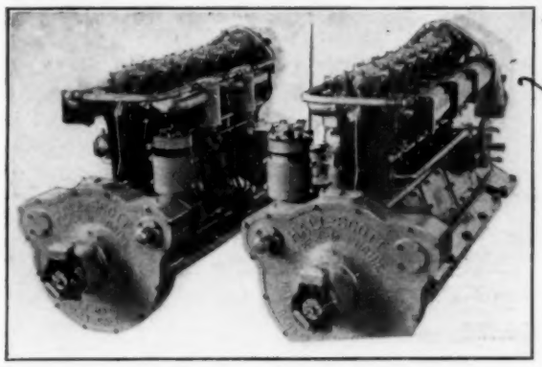
December 16, 1920 American Machinist Vol. 53, No. 25



BUILDING MOTORS ON THE PACIFIC COAST

By Fred H. Colvin
EDITOR-AMERICAN MACHINIST

THE Hall-Scott Motor Car Co., so named from its building of motor driven passenger cars for the steam railways and not from automobile manufactures, has a plant at Berkeley, Cal., across the bay from San Francisco. The concern was a growing one before the war and so prominent was it in the pioneer work of developing aircraft motors that E. J. Hall, its vice-president and general manager, was called into government service in connection with the design of the Liberty motor. The present plant is particularly attractive in many ways and is built to secure a maximum of light and convenience of which evidence will be seen in some of the illustrations that are to follow. Although we do not look for much motor manufacturing on the Pacific coast, the Hall-Scott Plant is an exception which is well worth noting. In comparing its methods with others, the difference in production must always be considered and it will be found that the tools, jigs and fixtures shown herewith are particularly well adapted for work under the conditions of this shop. The cylinders shown herewith are for marine engines, and are made of cast iron instead of steel as in the case of the Liberty motor cylinders, which they closely resemble.

The methods to be illustrated in this series differ somewhat from those used in the larger automobile shops, but they are none the less interesting. In fact it frequently takes a better engineer to devise methods and design fixtures for economical production where the output is limited than where almost any amount of money can be spent for special machinery.

The cylinders are first annealed in the furnace shown in Fig. 1, Fig. 2 being a closer view and showing more details of the tool used for handling them. The tool consists of a handle of sufficient length, divided into two prongs which first curve downward to act as a support and then turn upward as shown at *A*. Near the bottom of these prongs a yoke *B* is welded, this being so proportioned as to fit around the projection or "spigot" on the end of the cylinder casting as shown at *C*. This tool enables the furnace man to pick up the cylinders, when they are cold, and place them in any desired position in the furnace. In the same way it makes it easy for him to reach into the furnace for them when they are hot and remove them.

The first machining operation is that of boring as can be seen in Fig. 3 which shows a cylinder clamped in the chuck of a Libby lathe and also shows the substantial proportion of the boring bars. The pilot wheel *A*, controls the movement of a back-facing bar, which is shown in Fig. 6.

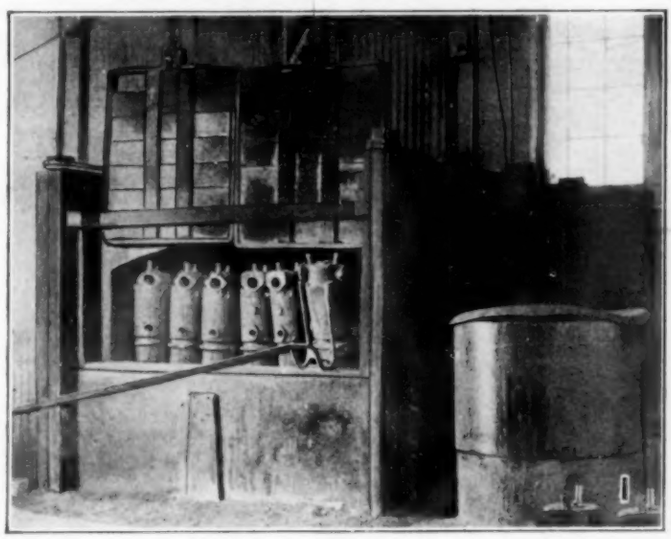


FIG. 1. ANNEALING CYLINDER CASTINGS

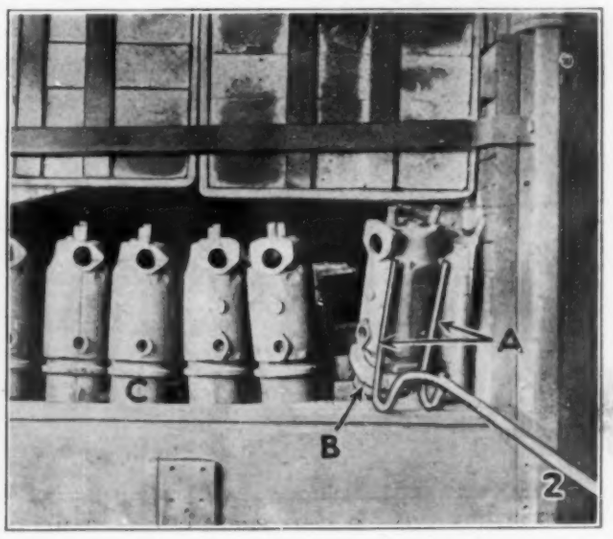


FIG. 2. THE TOOL USED FOR HANDLING THE CYLINDERS

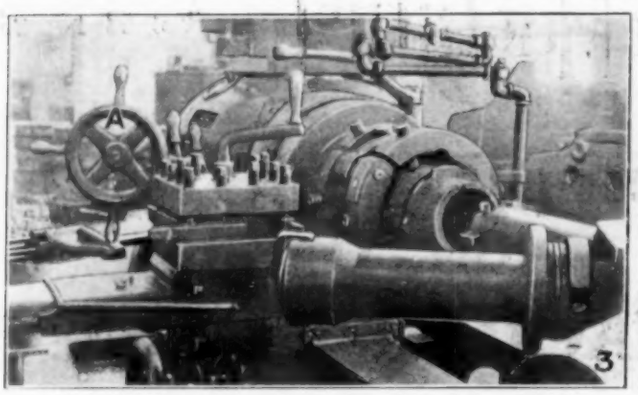


FIG. 3. THE FIRST MACHINING OPERATION

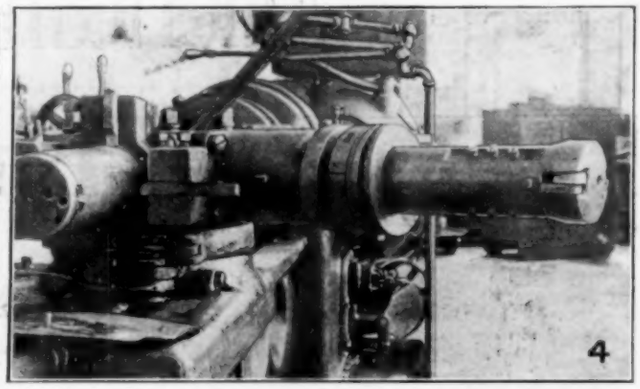


FIG. 4. PART OF THE TOOL SET-UPS

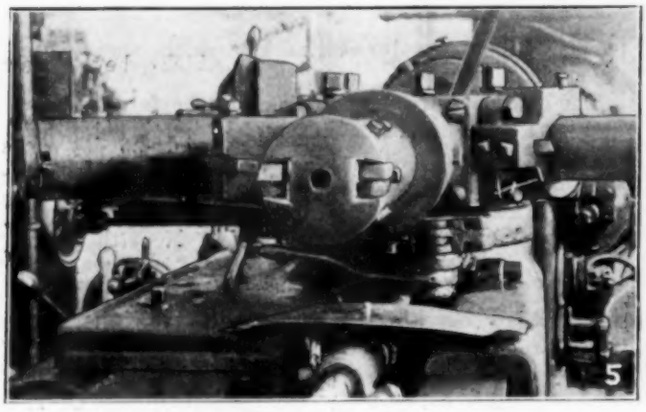


FIG. 5. SOME OF THE BORING BARS

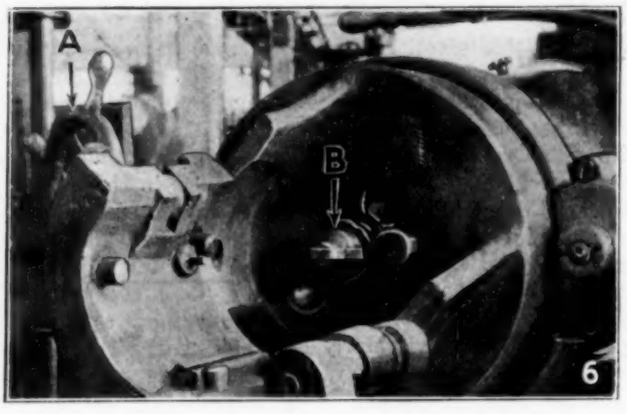
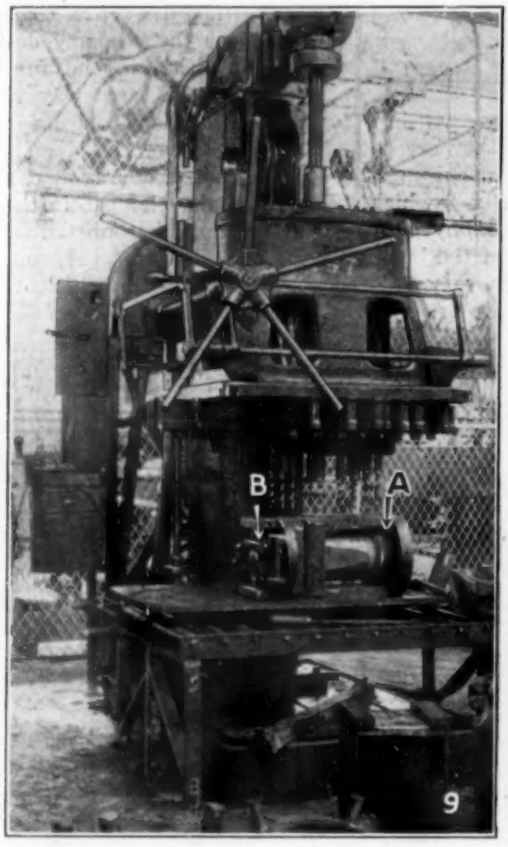
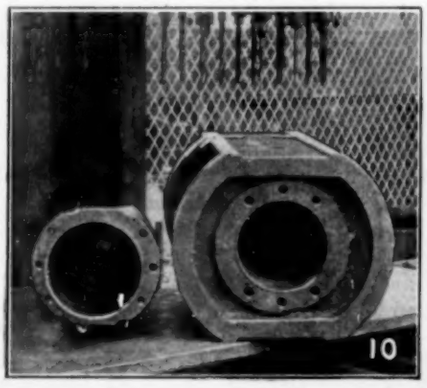
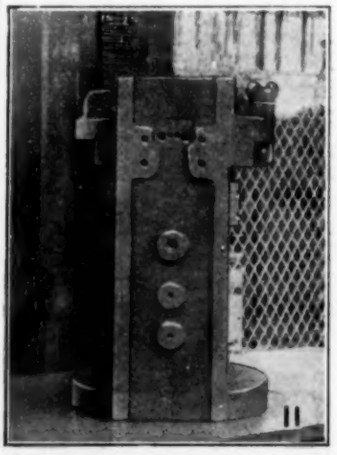


FIG. 6. THE CHUCK AND BACK-FACING CUTTER







FIGS. 9 TO 13. DRILLING OPERATIONS AND THE JIGS

Fig. 9—The multiple drill set-up. Fig. 10—Drilling bolt flanges. Fig. 11—Drilling the exhaust side. Fig. 12—Drilling intake holes. Fig. 13—The top of the fixture.

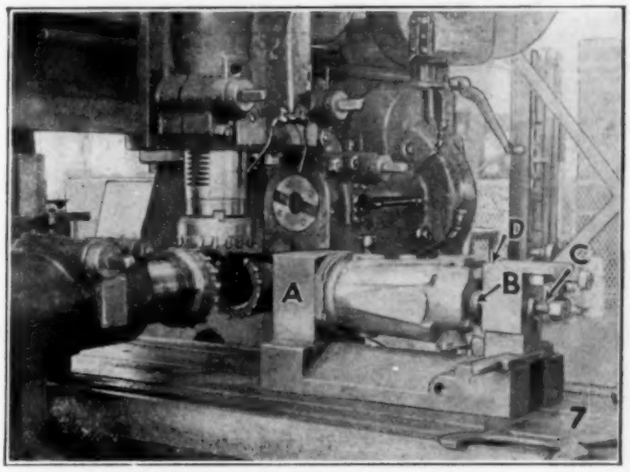


FIG. 7. MILLING THE SIDES

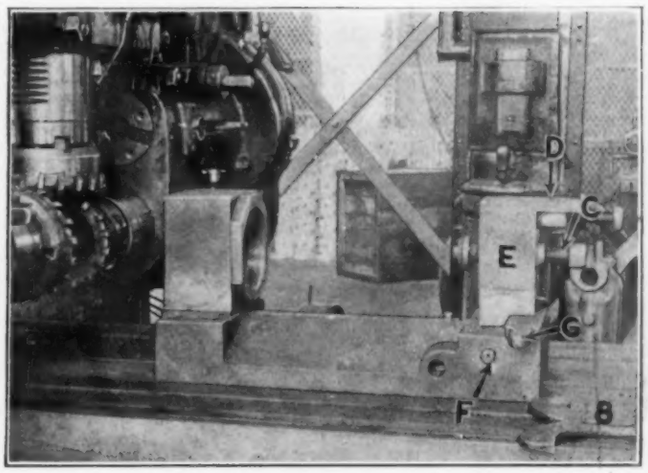
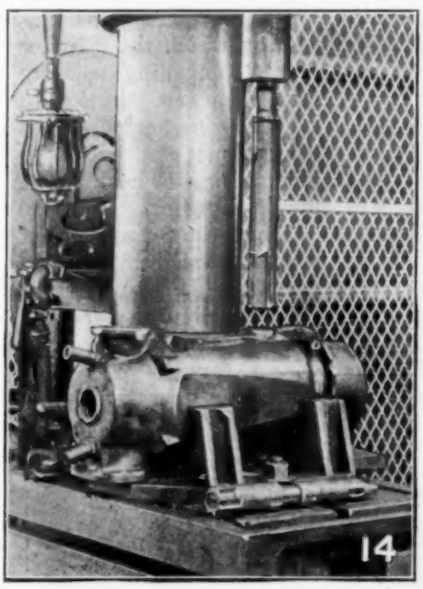


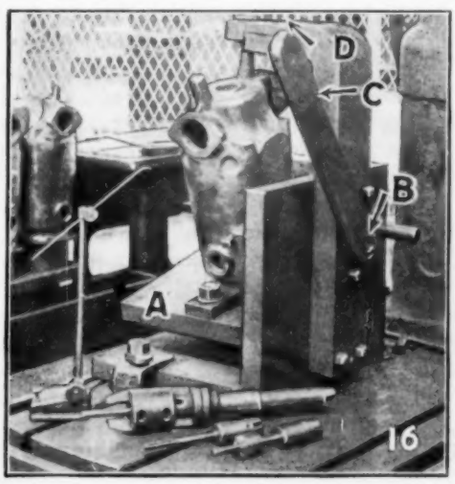
FIG. 8. THE MILLING FIXTURE

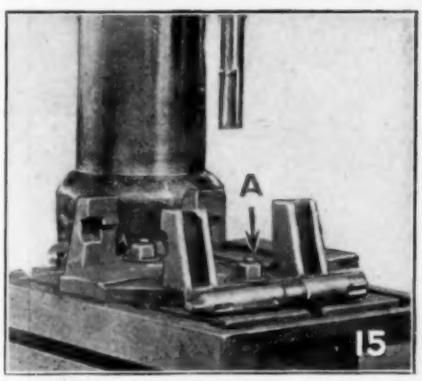
Figs. 4 and 5 show more of the tooling for cylinder boring and together with Fig. 3, give a good idea of the complete tool equipment for this job. Fig. 6 shows the chuck opened so that the various locating points can be seen. It also shows the wheel *A* and the back-facing cutter *B*, which it controls.

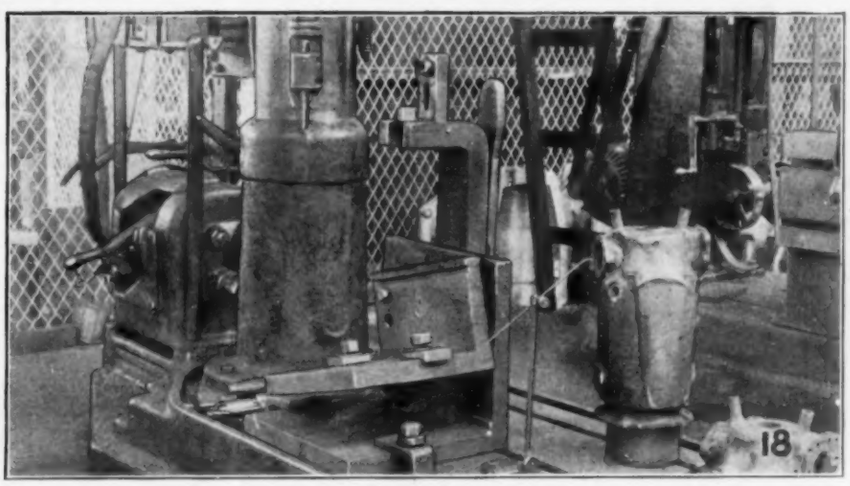
After boring and turning the projection, the cylinder goes to the milling machine shown in Fig. 7. The turned end which fits the projection goes into a bushing at *A*, while the pad *B* on the end of the screw *C* fits into the hole made by the back-facing tool previously referred to and holds the cylinder firmly and squarely in place. The cylinder is further supported and steadied by the block *D*. Only three spindles of the milling machine are utilized for this job after which it is necessary to reverse the cylinder so that the opposite flange and water outlet can be milled. Fig. 8 shows the fixture with the cylinder removed so that its construction can be clearly seen.

It will be noted that the block *E*, which carries the









FIGS. 14 TO 18. DRILLING OPERATIONS AND THE JIGS

Fig. 14—Drilling water jacket holes. Fig. 15—The drilling fixture. Fig. 16—Drilling the valve stem guide. Fig. 17—Another view of fixture. Fig. 18—The fixture without the cylinder.

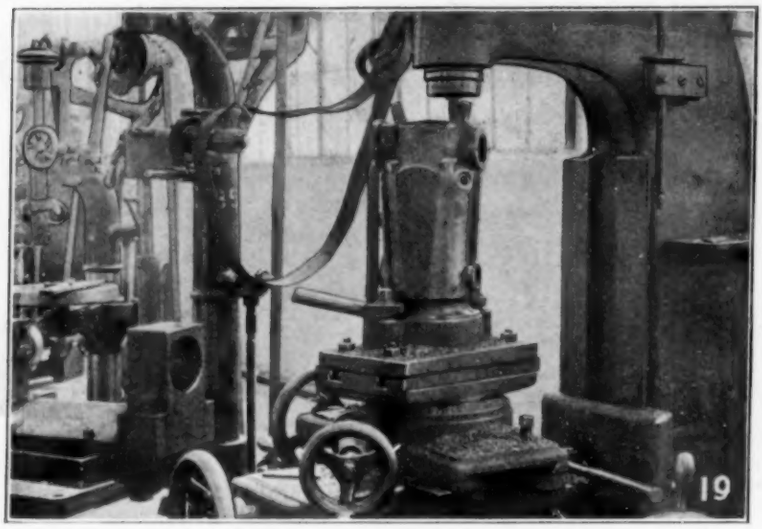


FIG. 19. PROFILING FOR CAM SHAFT HOUSING

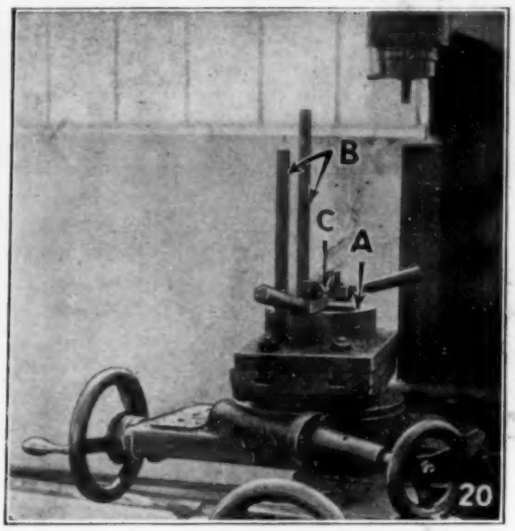


FIG. 20. THE FIXTURE USED

screw *C* and the slide *D* is pivoted at *F*, the lever *G* locking it in the upright position shown. After the cylinder has been milled the lever is swung around to the other side, the block *E* tipped back out of the way so that the cylinder can be easily removed and a new one put into place.

A Combination Drill Jig

Drilling comes next, Fig. 9 showing a Natco drill set up for drilling 21 holes in five operations. This view shows the type of box drilling jig used. The projection on the lower end of the cylinder fits into a suitable bushing at *A*, while the latch *B* holds it in place. Fig. 10 shows the end of the jig in which the six holes in the bolt flange are drilled and also a drilled cylinder at the left. Fig. 11 shows the jig used in drilling the 11 holes in the exhaust side, while Fig. 12 shows the jig for the bolt holes for the inlet flange. The bushings for the two holes in the top of the cylinder are carried in the swinging lid shown in Fig. 13.

Next comes the drilling and tapping of the cored holes into the water jacket as shown in Fig. 14, while Fig. 15 shows the drilling fixture with the cylinder removed. This fixture, as will be seen, is simply a base with four uprights, all planed square with each other, so that the cylinder can be readily placed in it without special clamping, it only being necessary for the bolt flange to be placed against the raised edge of the block *A*.

Drilling for Valve Stems

Drilling and forming the valve stem guide is shown in Fig. 16. As the valve stem holes are radial from a point well within the cylinder, it is necessary to swing the casting from this point in order to drill both holes at the one setting. The table *A*, on which the cylinder rests is pivoted at *B*, the lever *C*, affording an easy method of swinging the cylinder from one position to the other. The plate *A* has a hole to accommodate the cylinder projection so that the flange can be easily clamped to the plate. The drill bushing is held in the swinging arm *D*, which is shown swung up out of the way in Fig. 17. This view also shows the tongue *E* that acts as a guide for the side of the cylinder in which a mating groove has been previously milled. Fig. 18 gives a view of the fixture without the cylinder in place and shows more details of its construction.

Milling or profiling the bosses for the cam-shaft housing pad is shown in Fig. 19, this operation being done on a Pratt & Whitney machine. The construction of the milling fixture is perhaps shown more clearly in

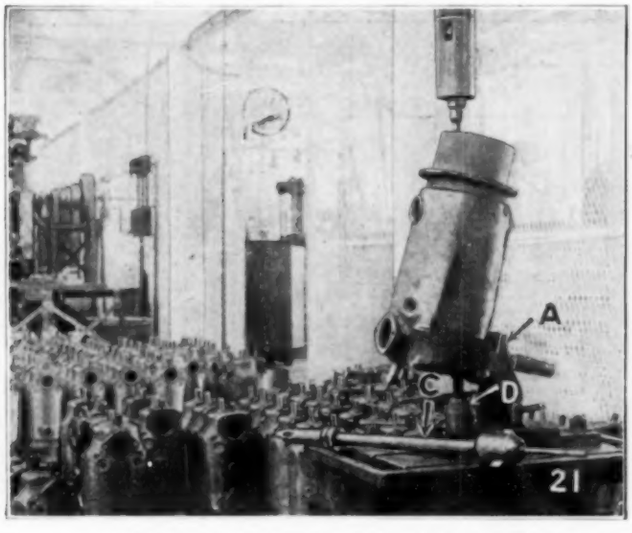


FIG. 21. MACHINING THE VALVE SEATS

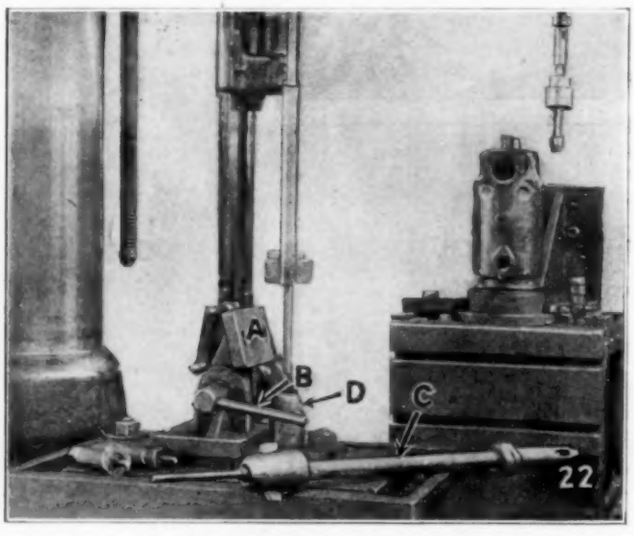


FIG. 22. THE FIXTURE AND TOOLS

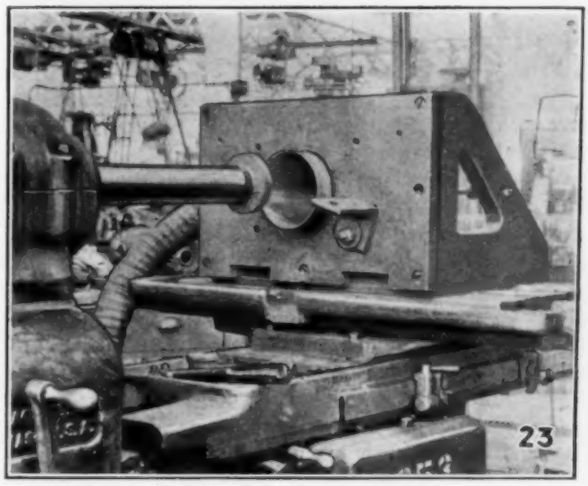


FIG. 23. GRINDING THE CYLINDER

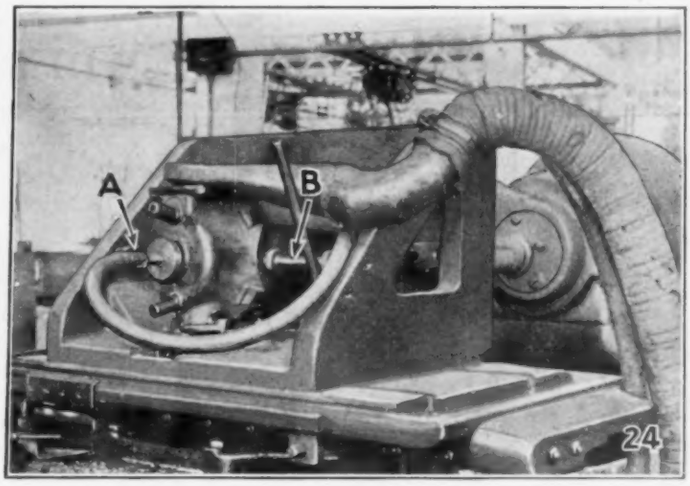


FIG. 24. EXHAUST PIPE CONNECTION FOR REMOVING DUST

Fig. 20, where may be seen the bushing *A* for the cylinder projection, the rods *B* and the swinging cams *C*, which lock the cylinder flange into position.

Boring Valve Seats

The method of boring the valve seats as well as the fixture on which this is done is shown in Figs. 21 and 22. The first shows the cylinder in position, located and supported by the pad *A* which turns on a central stud and can be locked by the handle *B*, Fig. 22. The valve seating tool is shown at *C*, this having a pilot which enters the guiding bushing *D*. The pad *A* holds the cylinder by means of the inlet and exhaust flanges, it being necessary to change its position for the second seat.

The final major operation is the finishing of the cylinder on the Heald grinding machine shown in Figs. 23 and 24. The first shows the lower end of the cylinder projecting through the angle plate, while Fig. 24 shows the method of connecting the exhaust pipe to the side flange so as to remove all the grinding dust from the vicinity of the machine. This view also shows the construction of the angle plate and the way in which the upper end of the cylinder is supported against side motion by the small jack screws *A* and *B*.

The methods used in machining the crankcase, piston and connecting rod will be shown in later articles.

Increasing Output of Labor

By George F. Kuhne

On page 591 of the *American Machinist* J. E. Bullard writes: "It is going to be necessary to greatly increase the output of labor if we are not to meet disaster. There is however not much opportunity of doing this along the line of introducing more machine methods. About all that can be done along that line has already been done."

The latter reference is somewhat erroneous, for improvements in mechanical or industrial processes are part of us and what is new today is primitive tomorrow. The thought "impossible" has steadily lost ground, for many of the so called impossibilities have been accomplished. The thinker should always bear in mind the following: All is here that we desire, we have but to recognize it and find the means of accomplishment for our purpose. This I dare say, has indeed been demonstrated over and over again; we have but to look about us to realize its truth.

Unfortunately, all employers are not in a position financially to provide the modern idea of gymnasium, lunch rooms, hospitals, etc. as additions to their plants, yet modern times demand that so far as is consistent with finances such improvements be made as an investment representing increased efficiency of the workers and dividends. Proper light and air regulation is carried on by most progressive concerns.

Another important item relative to labor output is—Know your man. Fit the man to the job and the job to the man. Not so long ago the foreman would hire a man, later fire him, reason—no good; then another man. Now this is not accepted, for personal prejudice and hasty judgment are detrimental to the success of any concern or department (likewise the foreman). This labor turnover is investigated and reveals perhaps that all conditions as to light, air, hours, wages, etc. are in some instances better than in other concerns in the locality. The result therefore, may be due to improper selection of help, or the foreman's not knowing his men.

Keeping men on the job will send the curve of increased output upward. This may be accomplished by the department foreman being a different kind of a foreman than he used to be. He should study the human as well as his mechanical problems, for perchance the loss of men can be attributed directly to himself. Jumping to hasty conclusions should be averted and a study of his man may reveal that he would fit in somewhere else in the plant. Therefore, the foreman should familiarize himself with the work done in other departments in order to recommend a judicious transfer.

It behooves the plant executive to permit the foremen to become familiar with the nature of work done in the various departments, but such inspection should be done during working hours. This enables the foreman to gain increased knowledge of the product and the sequence of the operations, which is important in manufacturing and will place him in a better position to recommend a transfer.

There will be no great advance in production unless the human machine is studied and ways and means devised and incorporated for consistent and harmonious operation with the mechanical or industrial improvements. Much is required in order to obtain the desired result.

Wave Transmission of Power

The practicability of the theory of transmitting power through a column of liquid, known as the "Wave Transmission of Power," was proved during the war by its application in the C. C. gear for the automatic firing of airplane guns. More recently the wave method of transmitting power has been applied to rock-drills, jackhammers, riveting hammers and riveting machines. The accompanying article on the theory of wave transmission of power is from the inventor's technical treatise. It is taken from a booklet published by W. H. Dorman & Co., Ltd., Stafford, England.

ONE of the fundamental problems of mechanical engineering is that of transmitting energy found in nature, after suitable transformation, to some point at which it can be made available for performing useful work.

The methods of transmitting energy known and practiced by engineers are broadly included in two classes: Mechanical, including hydraulic, pneumatic and wire-rope methods, and electrical methods.

The present brochure deals with a new method—the general principles of which have been enumerated by the inventor, G. Constantinesco—by which the problem has been solved.

All methods of transmitting power through liquids, known as hydraulic methods, as hitherto applied, depend on the continuous transmission of pressure through a liquid so that pressure generated at one end of the line is utilized at the other end. The liquid in this form of transmission merely acts as an incompressible flexible connecting rod.

The known pneumatic methods involve a flow in the pipes always in one direction, pressure being generated at one end of the system and utilized at the other end, but in this case the elasticity of the air employed is sometimes taken advantage of in the power utilizers.

In the wire-rope methods the motive power is, as it were, attached by a string, as near as possible inextensible, to the power utilizers; the system depends on the longitudinal motion of the wire as a whole.

In all these known methods of applying mechanical means to the transmission of power from one point to a distant point elasticity has no direct function and is generally ignored.

The author's system depends on the elasticity of the medium through which the energy is transmitted. The essential feature of the system is that the particles of the medium employed, whether solid, liquid, or gaseous, are in a state of vibration about a mean position.

According to the new system energy is transmitted from one point to another, which may be at a considerable distance, by means of impressed periodic variations of pressure or tension producing longitudinal vibrations in solid, liquid, or gaseous columns. The energy is transmitted by periodic changes of pressure and volume in the longitudinal direction, and may be described as wave transmission of power or mechanical wave transmission.

There are many instances in nature of transmission of energy by vibrations; wave motion may almost be said to be the natural method of transmitting energy.

Let us consider some known phenomena of vibrations of particles of matter:

The transmission of sound through air is due to a vibratory motion set up by the source in the surrounding air; each particle of air in the neighborhood of the source is put into a state of vibration about a mean position.

A common method of producing sound is to cause an elastic diaphragm to vibrate, impressing its vibrations on the surrounding air. By isolating the air to which the vibrations are transmitted, as, for instance, by means of a speaking-tube, the sound can be directed and a given quantity of energy of vibration produced can thus be transmitted over great distances.

Consider what is taking place in the tube when the contained air is set in motion by a diaphragm in a plane normal to the axis of the tube and vibrated about a mean position.

The first movement of the diaphragm in the direction of the tube displaces some air in the tube; this displacement is resisted by the still air further along the tube, so that a zone of compressed air is produced in the immediate neighborhood of the diaphragm. At the same time the moving diaphragm is giving velocity to the particles of air in its immediate neighborhood, and these particles communicate their velocity to those beyond them, and thus any disturbance once produced by the diaphragm must travel forward along the tube. On the return movement of the diaphragm the compressed air in its immediate neighborhood, being elastic, expands, and we have then a zone of low-pressure air in contact with the diaphragm.

The continuing vibrations of the diaphragm produce alternate zones of high and low pressure, and the disturbances so produced travel forward along the tube until the whole of the air particles in the tube are in a state of vibration; it has been found that the zones of high and low pressure travel along the tube with a definite velocity of about 330 meters per second, this velocity varying slightly with the diameter of the tube.

In a similar manner sound energy travels through other elastic media. The velocity through water has been found to be about 1,435 meters per second.

As hitherto employed for the transmission of power in hydraulic and telpherage systems liquid and solid connections have been considered as movable *en bloc*, and for practical purposes incompressible and inextensible. Both liquid and solid columns, however, are elastic, and this property can be made use of to transmit energy by vibrations of the particles of matter of which they are built up. We will first consider the case of liquid columns.

Assume that we have 150 meters of wrought-iron steam pipe, of 2.5 cm. diameter and 0.5 cm. thickness of metal, closed at one end and filled with water; and suppose a fluid-tight piston is forced into the pipe under a steady pressure of 35 kg. per square centimeter. If the liquid were incompressible the increase in volume of the containing pipe under the pressure would allow the piston to enter about 1.5 cm.

If the pipe were absolutely inexpansible the pressure would compress the water to an extent that would allow the piston to enter about 26 cm.

It is seen, therefore, that the compression of the water in a wrought-iron steam pipe of the size considered is the chief factor in the changes of volume which take place under pressure, and that the expansion of the containing pipe is almost negligible.

On removing the pressure from the piston the water will again expand to its original volume. With other liquids similar results will be obtained. Assume now that the pipe, instead of being closed rigidly at one end, is closed by a light floating piston held always in contact with the liquid column, but free to move with the liquid; assume further that the working piston, instead of being slowly pushed into the pipe, is connected to a rapidly rotating crank, so that it moves with a simple harmonic motion, and that in addition to the piston impulses a steady pressure acts on the liquid column at both ends. The only resistance to the movement of the piston is then the inertia of the liquid column, and if the column is short the liquid will move as a solid mass. If, however, the column is of considerable length the motion of the layers of liquid nearer the working piston is resisted by the inertia of the more remote layers, and on the in-stroke of the piston the liquid in its neighborhood will be compressed and its volume diminished; it follows that the motion of the layers of liquid remote from the piston will be less than that of layers nearer to it.

At any given speed of rotation of the crank there will be a point in the liquid column at which, on the completion of the in-stroke of the piston, no movement of the liquid has occurred. The liquid between this point and the piston will at this moment be in a state of compression varying from a maximum at the piston to zero.

At the moment of maximum velocity of the piston the velocity of the layer of liquid in contact with it will necessarily be greater than the velocity of the more remote layers, and the kinetic energy of the layers nearer the piston will, therefore, be transmitted in the forward direction along the column. The energy expended by the piston in its forward stroke at the end of this stroke is present in the liquid column, partly in the form of potential energy due to the decreased volume of the liquid under compression and partly as kinetic energy.

On the return stroke of the piston the compression of the layer of liquid in contact with it decreases, and expansion of the liquid takes place between the piston and the point in the column at which the pressure is a maximum. As the point of maximum pressure moves away from the piston at the commencement of the return stroke the velocity of the layer of liquid in contact with the piston is reversed, while the pressure of this layer diminishes until the piston is at the end of its out-stroke. At the end of this out-stroke the layer of liquid in contact with the piston is instantaneously at rest.

As the crank continues rotating there are thus impressed on the liquid column a series of impulses sending a series of changes of pressure and volume along the column, the particles of liquid each vibrating about a mean position.

The considerations dealt with above as regards vibrations in liquid columns apply also to solids; this may be shown by considering the case of a long helical spring, one end of which is subjected to periodic shocks in the longitudinal direction. At each shock the end of the spring will be compressed and will again expand when the impulse is removed; the effect of the impulse, however, will travel along the spring in the direction of the shock with a definite velocity. The inertia of the coils of the spring remote from the end provides the resistance necessary to compress the first coils, but on the removal of the impulse expansion takes place in both directions, so that the wave of pressure and displacement travels along the spring.

An example of this occurs in practice in the case of the recoil springs of heavy ordnance, in which it has been noticed that pulses in the movements of the gun take place, due to the zones of compression in the recoil springs produced by the sudden shock of firing.

Consider now a very long steel wire connected to a crank so that the end is given a simple harmonic motion in the longitudinal direction, and suppose that the tension given by the crank is superposed on a steady tension in the wire so that no part of the wire is ever in state of longitudinal compression.

As the crank rotates the end of the wire will be subjected to alternate maximum and minimum tensions occurring periodically; under certain conditions the wire, being elastic, will not move *en bloc*, but the periodic changes of tension will produce periodic displacements of the particles of the wire in the longitudinal direction, each particle vibrating about a mean position as in the case of the fluid columns discussed above.

In the transmission of sound through air we have seen that a series of vibrations is imparted to the air particles, causing them to move about a mean position; and thus a series of waves of alternate compression and rarefication travels forward from the source. If these waves fall on a sensitive receiver, such as the drum of the human ear, the receiver is set in vibration and the sound is heard. This is, in fact, an example of the transmission of energy by mechanical wave motion. Similarly, sound is transmitted through liquids and solids.

In order that a receiver may be able to respond to the vibrations falling upon it certain conditions are essential. The part of the receiver which is to be put in motion must be capable of vibrating at the periodicity of the vibrations which fall on it.

In the case of the human ear very sensitive receivers are found, which are tuned to or capable of adapting themselves readily to vibrations of different periodicity within certain limits of frequency. When, however, we come to the problem of detecting vibrations by mechanical means, and still more so when it is desired to transmit power economically by means of these vibrations, it is necessary that the part moved should be designed so that it can respond to the particular periodicity of vibration by which the power is transmitted. It is further necessary, if the part moved has to perform useful work, that the work should be performed in such a manner that the ability of the receiver to vibrate in unison with the impressed vibrations is not interfered with.

Although in some cases in which energy has been heretofore transmitted by vibrations in matter—as, for instance, the case of a tuning-fork made to respond to sound waves of its own frequency—the question of the

period of vibration of the receiver has been considered; in no case, up to the present, has the tuned receiver been adapted to the performance of work. For the transmission of power by mechanical wave motion it is therefore necessary to devise means by which the vibrations in the transmission line may be received and converted to use.

Let us now consider further the case of a rapidly

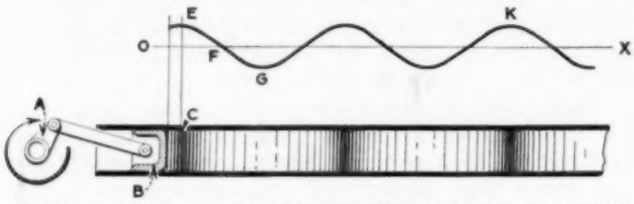


FIG. 1. RAPIDLY ROTATING CRANK CAUSING A PISTON TO RECIPROCATE AT THE END OF A LONG PIPE CONTAINING LIQUID

rotating crank causing a piston to reciprocate at the end of a long pipe containing liquid. We have seen above that a series of zones of high pressure and compression of the liquid alternating with zones of low pressure and expansion of the liquid are produced, and that these zones travel forward along the pipe.

In Fig. 1 suppose the crank A to be rotating uniformly, causing the piston B to reciprocate in the pipe C, which is full of liquid. At each in-stroke of the piston a zone of high-pressure is formed, and these zones of high pressure (shown by shading) travel along the pipe away from the piston; between every pair of high-pressure zones is a zone of low pressure shown light in the figure. The pressure at any point in the pipe, therefore, will go through a series of values from a maximum to a minimum, and these values will repeat periodically. Let the line OX represent the value of the mean pressure, then, with the piston in the position illustrated, the instantaneous pressures at different points along the pipe may be represented by the ordinates of the sine curve $EFG \ldots K$. As the rotation of the crank is uniform it will be evident that the distances between successive points of maximum pressure will be equal. This uniform distance along the pipe at which the values of the pressure are repeated is the wave length of the vibrating movement of the liquid.

If v is the velocity with which these waves travel along the pipe, and n is the number of revolutions in unit time of the crank A, it will readily be seen that the wave length y must be $\frac{v}{n}$.

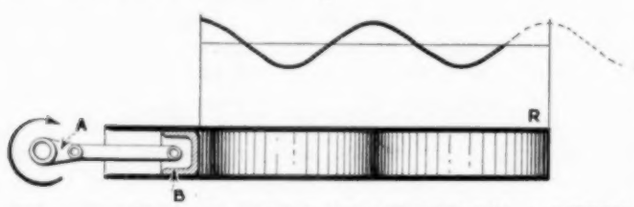


FIG. 2. RAPIDLY ROTATING CRANK CAUSING A PISTON TO RECIPROCATE AT THE END OF A PIPE OF FINITE LENGTH CLOSED AT THE POINT R

Assume now that the pipe is of finite length, Fig. 2, and is closed at the point R at a distance from the piston B equal to an exact multiple of the wave length, and suppose that the stroke of the piston is small compared with the wave length.

The wave of compression will be stopped at R and reflected, and the reflected wave will travel back along the pipe.

If the crank continues its rotation at uniform speed, with the length of pipe and speed of rotation we have taken—*i.e.*, with the distance from the piston B to the stop R an exact multiple of the wave length—a zone of maximum pressure will be just starting from the piston at the instant the reflected zone of maximum pressure reaches it; so that we shall have a wave of double the original amplitude traveling forward along the pipe. The next revolution of the crank will again add to the amplitude of the wave sent forward; and so on with successive revolutions. The result of this continual pouring in of energy is that the maximum pressure increases without limit till ultimately the pipe bursts.

It should be noticed that in a wave of greater amplitude the maximum pressures are increased, and the maximum velocities and distance of travel of the oscillating particles are also increased.

Suppose now that instead of closing the pipe rigidly at R we have at R a piston M connected to a crank N similar to A as shown in Fig. 3.

Suppose that the crank N is rotating at the same angular velocity and in the same phase as the crank

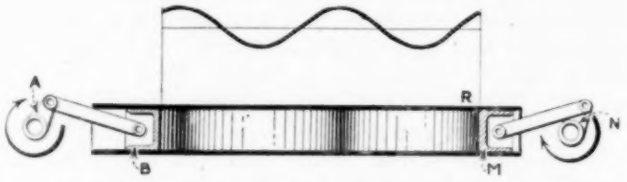


FIG. 3. SAME CONDITIONS AS IN FIG. 2 EXCEPT THAT INSTEAD OF CLOSING THE PIPE R, A PISTON AND CRANK ARE SUPPLIED AT THAT POINT

A. If the liquid column were continued beyond the piston M it is evident that the movement of the piston would produce in this column a series of waves which would be exactly similar to and a continuation of the waves between B and M.

The piston M, therefore, if moving synchronously with B, will be able to take up the whole energy of the waves produced by B and traveling along the pipe.

It will be seen further that the piston will be able to take up and utilize the whole of the energy of the waves traveling to it if placed at any point of the pipe, provided its time period of reciprocation is the same as that of the piston A, and provided that the phase of its movement is such as would produce a continuation beyond it of the impinging waves; that is to say, provided the piston movement is in phase with the movement of the layer of liquid in contact with it.

In the transmission of power by wave motion in this example the maximum pressure in the pipe will at no point exceed the maximum pressure in the neighborhood of the working piston, however long the transmission line may be; and will be the same whether the line is a single wave length or any number of wave lengths. Also the two pistons may be moving in the same or in opposite directions, and their motions may differ in phase by any angle according to the relation between the distance from one to the other and the wave length.

In the example above discussed the whole of the energy put into the liquid column by the piston B can be taken up by the piston M. If more energy is put in by B than is taken up by the piston M, assuming

no frictional losses, it is obvious that reflected waves must be formed as the direct waves fall on the piston *M*. The result of this will be that the surplus energy will remain in the liquid and the continuation of the rotation will continually pour in energy, increasing the maximum pressure indefinitely till ultimately, as in the case of the closed pipe, the pipe will burst.

Suppose that, in the case of a closed pipe having a length of several wave lengths, a vessel *A* completely filled with liquid, of considerable volume in proportion

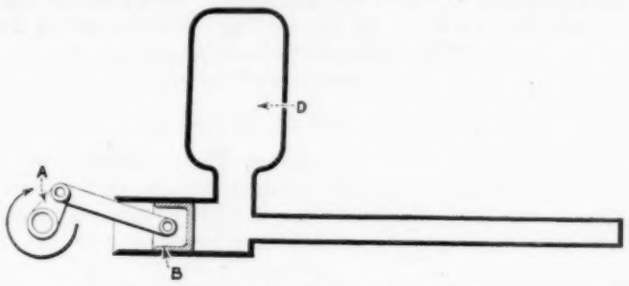


FIG. 4. ADDITION TO CLOSED PIPE, HAVING A LENGTH OF SEVERAL WAVE LENGTHS, OF A VESSEL OF CONSIDERABLE VOLUME IN PROPORTION TO THE STROKE VOLUME OF THE PISTON

to the stroke volume of the piston *B*, and with rigid walls, is placed in communication with the pipe in the neighborhood of the piston, as shown in Fig. 4. At each in-stroke of the piston a flow will take place through the entrance to the vessel *D*, and the liquid in this vessel will be compressed, and at each out-stroke of the piston the liquid in the vessel will again expand. According to the volume of the vessel more or less liquid will flow into it and out of it at each revolution of the crank. The capacity *D* will thus act as a spring, taking up the energy of the direct and reflected waves when the pressure is high, and giving back this energy when the pressure falls; the mean pressure in the vessel *D* and in the pipe will be the same, so that when the successive reflected waves in the pipe have been produced and have reached a certain amplitude equivalent to this mean pressure the piston will merely exert energy in compressing the liquid in the vessel *D* on its in-stroke, and the liquid acting as a spring will restore this energy to the piston on its out-stroke. The result of this is that when the reflected waves have been produced there will be a series of *stationary* waves in the pipe, and no further increase of energy in the liquid will take place and the pressures in the pipe will never exceed the fixed limit.

By using a vessel such as *D*, therefore, the pipe can be completely or partially closed. It is therefore possible to place at the far end or other point of the pipe apparatus for utilizing only part of the energy of the wave, and the rotating crank *A* will only require to perform work to the extent of the energy utilized.

Consider now a case (Fig. 5) in which waves are transmitted by a reciprocating piston *A* along a line *EEE* provided with branches. Assume that the pipe *E* is closed at *P* at a distance of one complete wave length from the wave generator *A*; and that there are branches *BCD* at the half, three-quarter and full wave length distances respectively. We know from the cases discussed above that if the cock *P* is closed and the cock *D* opened, leading to a motor *L* rotating at the synchronous speed, the motor *L* will be able to take up the whole of the energy put into the liquid by the generator.

We also know that if all the cocks are closed stationary waves will be produced in the pipe *E* having maximum variations of pressure at the end *P* and at the half wave length *B*. At these points the flow will always be zero, while the pressure will alternate between maximum and minimum values determined by the capacity *F*, consisting of a closed vessel filled with liquid. At the quarter and three-quarter wave length *G* and *C* respectively the flow will alternate between maximum and minimum values, but the variation of pressure will remain zero.

In this case the points of maximum pressure and maximum movement do not travel along the pipe, but are fixed in position, and theoretically no energy flows from the generator. At the points of maximum movement no variation of pressure will occur; and at the points of maximum pressure variation there will be no movement of the liquid.

It is evident, therefore, that if the cock *B* leading directly to a motor M be opened the motor M, running at the synchronous speed, will be able to take up all the energy given to the line. The stationary half-wave between *A* and *B* will therefore disappear, its place being taken by the forward traveling wave, while between *B* and *P* the stationary wave will persist. If the cock *C* leading to the motor *N* at the three-quarter wave length be opened, all other cocks being closed, since at the point *C* the variation of pressure is always zero, no energy can be taken up by the motor, and the stationary wave will persist in the whole length of pipe.

If the motor be connected at any intermediate point part of the energy will be taken up by the motor, while the stationary wave will persist but will be of reduced amplitude between the generator *A* and the motor. The state of the liquid between the generator *A* and the motor may be considered as the resultant of two superposed waves; one a stationary wave and the other a traveling wave of flowing energy.

Assume now that the motor is not capable of taking up all the energy which can be transmitted to the line

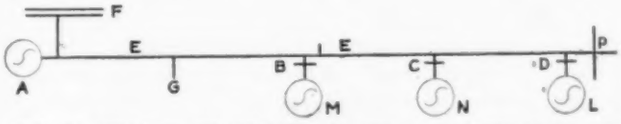


FIG. 5. WAVES TRANSMITTED BY A RECIPROCATING PISTON ALONG A LINE PROVIDED WITH BRANCHES

by the generator *A;* then we shall have superposed in the pipe a system of stationary waves and a system of waves traveling along the pipe, so that there will be no point in the pipe at which the variation of pressure will always be zero, consequently a motor connected at any point of the pipe will be able to take up and utilize a portion of the energy which is transmitted to the line.

We see, therefore, that if we have a number of motors all connected to the line every one of them will be able to take some energy and do useful work. It is only when no energy is being utilized that points at which the variation of pressure is *permanently* zero can exist.

It is seen from the preceding discussion that periodic variations of pressure and volume can be impressed on columns of gases, liquids or solids; and can be made to travel along such columns, causing the several particles to be set in vibration about their mean positions.

It is further clear that under certain conditions the mechanical energy so transmitted can be made available for the performance of useful work.

Early Traces of the Toothed Wheel—I

By H. H. MANCHESTER

In the author's series of articles on the "Evolution of the Workshop," he touched upon a number of subjects which deserve separate treatment. One of these is the toothed wheel, the history of which is here discussed.

THE origin of the toothed wheel has been accredited to both Egypt and Babylonia. The reason for assigning its discovery to the Egyptians is because toothed wheels have been used on the water-wheels of the Egyptians since time immemorial; but in making a rather careful search through thousands of Egyptian tomb pictures, the writer has failed to discover any gearing of this nature.

The evidence both for and against its discovery by the Babylonians is very slight. Babylonian pictures of perhaps 700 B. C. show the use of pulleys and levers, but not of toothed wheels. We know that a wheel with rays was used in raising water in Babylonia in early times, but there is no evidence that these spokes were combined in gearing.

First Known Mention of Friction Gearing

Probably the first known mention of wheels used in gearing is by Aristotle about 330 B. C. In the first chapter of his "Mechanical Problems," he wrote, that if one circle touches another circle, the diameter of the first circle being moved, the second circle will be moved in a direction contrary. Aristotle made no mention of teeth, however, but described only friction gearing. By this time one machine had come into use, with which it is conceivable that some kind of gearing might have been employed. This was the windlass, which was extensively adopted for the moving of heavy materials, especially in building.

It seems likely also that the Archimedian screw for raising water followed, rather than preceded, the use of the screw for other purposes. This suggests that the worm and rack had already been known, but is far from being proof.

Gearing Known to Ancient Greek Mathematicians

There is no doubt, however, that the toothed wheel was known to the ancient Greek mathematicians. Otesibius, who lived about 250 B. C. and who is credited with the construction of the siphon, hand bellows, fire engine and water organ, is said by the Roman architect, Vitruvius, to have constructed a water clock in which a gearing of toothed wheels was used to disclose the passing of time. This clock was said to have, "a rack and revolving drum, both fitted with teeth at regular intervals, which, acting upon one another, induce a measured revolution and movement." The clock had various fanciful features, for, according to Vitruvius, "Other racks and other drums, similarly toothed and subject to the same motion, give rise by their revolution to various kinds of action by which figures are moved, cones revolve, pebbles or eggs fall, trumpets sound, and other incidental effects take place."

About 230 B. C. Philo of Byzantium, according to ancient tradition, made use of a wheel with spokes acting upon a rack for the purpose of raising water. Almost nothing of the works of Otesibius or Philo is extant, but a number of their inventions seem to have been included by Hero of Alexandria, who lived in the second century B. C., in his various treatises which he states contained the devices of others as well as his own, though he does not differentiate the sources.

Hero's Treatise on Mechanics

In his treatise on mechanics, Hero shows how a weight may be raised by toothed wheels and pinons, Fig. 1. He also illustrates the use of the endless screw with a toothed wheel and rack, and gives an example of inclined teeth.

In his writings on pneumatics, Hero describes a toothed wheel with a rack, toothed wheels at right angles, and a cam action. The cam action mentioned by Hero, while not particularly striking in itself, was used in connection with a windwheel to blow an organ, which is proof that the windwheel, as a philosopher's toy, dates back more than a thousand years before its employment for practical purposes in Europe.

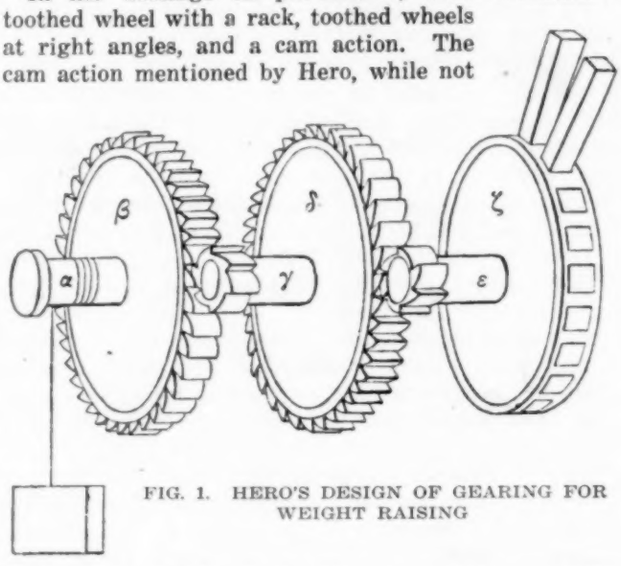


FIG. 1. HERO'S DESIGN OF GEARING FOR WEIGHT RAISING

Early Use of Iron Teeth

The toothed wheel with a rack is used in a self-trimming lamp, which, as the oil sinks lower, would push the wick along to make up for the part burned. This is shown in Fig. 2 and is important, as it expressly states that the rack should be of iron.

This is one of the very few ancient notices of iron teeth or teeth that fit into one another. There is no doubt that the regular usage in ancient times was to make teeth by extending the spokes of the wheel, or by setting oblong wooden blocks into either the circumference or face of the wheels. The statement can hardly be made too sweeping that in ancient times toothed gearing was regularly of the spur and pinwheel type, or if in the same plane, consisted merely of one flat block striking against another. The drawings of Hero are probably more typical of a period when the copy was produced than of the time of Hero himself. While they diagram in general the propositions as annunciated

by Hero, the teeth of the wheels probably represent the knowledge of a later period, and, simple as they are, are nevertheless more advanced than those of Hero's time. This is no doubt true of the cut, Fig. 3, of the worm gearing, which required a comparatively advanced form of teeth.

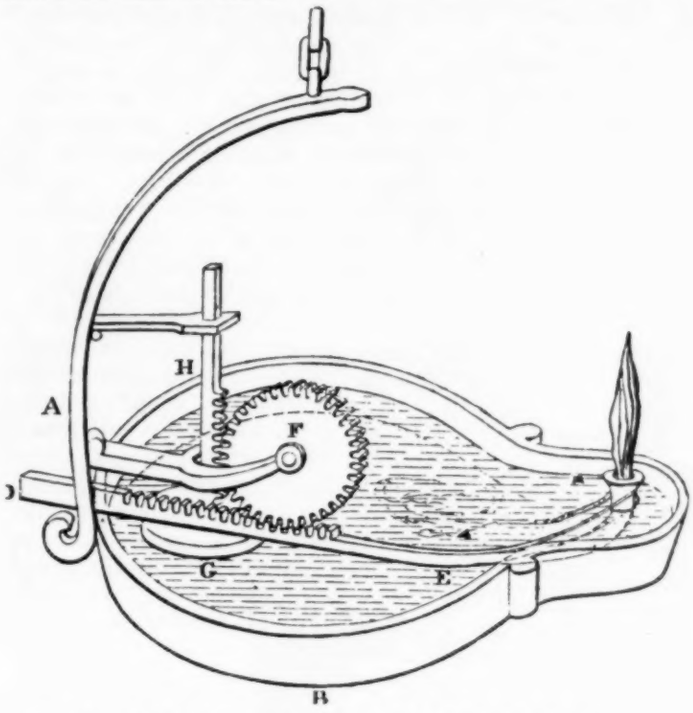


FIG. 2. EARLY SELF-TRIMMING LAMP WITH IRON-TOOTHED RACKS

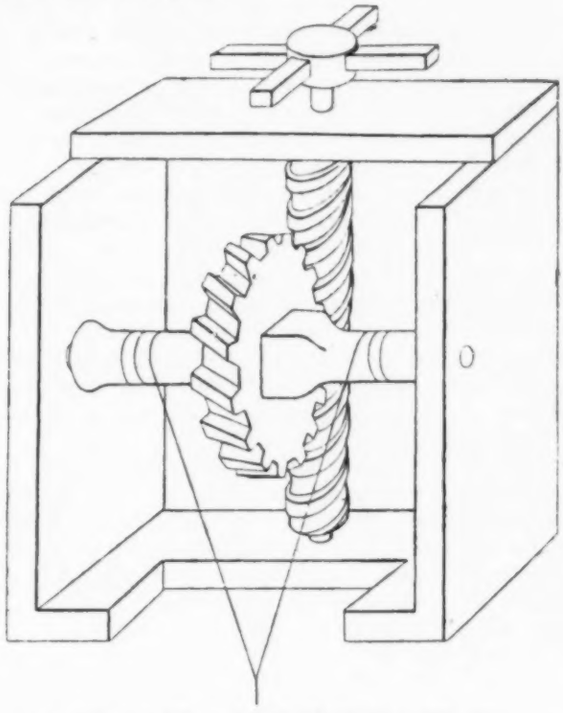


FIG. 3. HERO'S ADVANCED DESIGN ON WORM GEARING

The Roman architect, Vitruvius, who wrote about 200 B. C., seems to have made use of the toothed wheel in his water mill for grain, although the text of his description is somewhat doubtful.

Use of Paddle Wheels on Ancient Ship

One very curious use made of the toothed wheel by Vitruvius was in connection with paddle wheels on a ship, but the most curious part of it is that the paddle wheels were not used to drive the ship, but to measure the speed at which the ship was moving. The paddles were at the side of the vessel, much as in the case of a side-wheel steamer. On the center of the axis between them was a drum with one cam. This struck in turn 400 teeth on another drum. These in turn were geared with the teeth of still another drum, each revolution of which released a small stone, and the distance was measured by counting the stones.

Later, when the Roman Empire was overrun by successive hordes of barbarians, learning fled to the Eastern Empire of Constantinople. In Western Europe the knowledge of the Greek and Latin thinkers was forgotten, and only those mechanical inventions were retained which were in constant practical use. Even in the East the overshadowing of the Greek philosophy by Christianity tended to let the old Greek thinkers be neglected and forgotten. For this reason many ideas were lost, and not rediscovered until after several centuries. As a consequence there was little progress made in gearing during the first part of the Middle Ages.

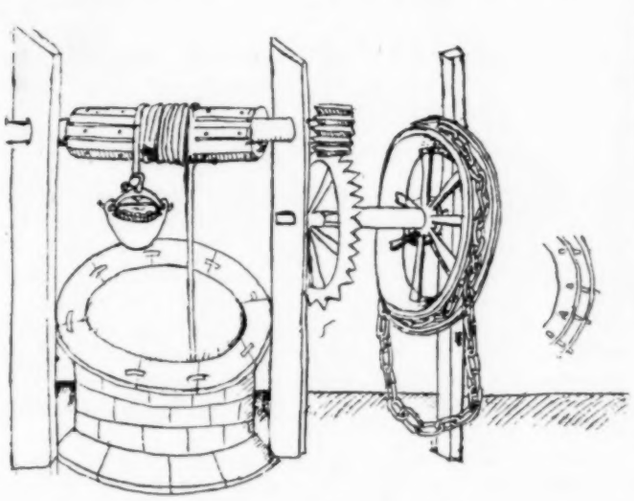


FIG. 4. GROTESQUE SKETCH OF BUCKET CONVEYOR

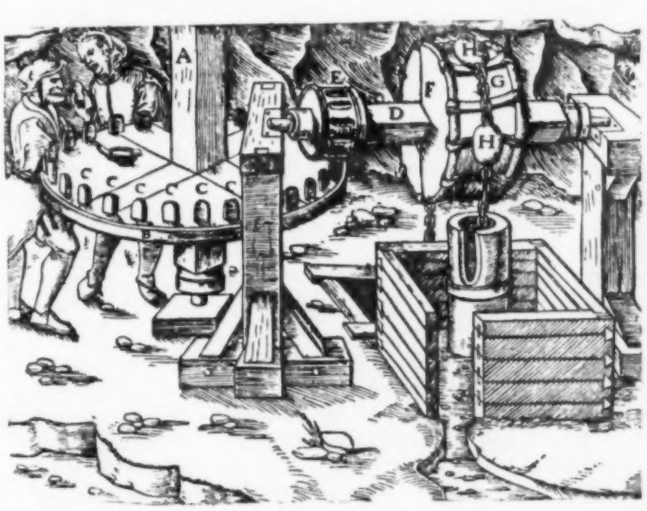


FIG. 5. AGRICOLA'S IMPROVED LANTERN AND FACE WHEEL

An illustration of a water mill of the twelfth century, although much distorted in the drawing, shows on the axis of the waterwheel a vertical pin wheel which is geared to a small vertical lantern on the axis of the lower mill stone.

The Invention of the Lantern Pinion

Crude as the lantern is, the evidence points to the fact that it was an improvement over the spur and pinwheel of the period, and that it was invented some time in the early Middle Ages—in fact, the construction of the lantern is such that it might well have been devised at first to give greater stability to the pins by fixing them at both ends in the face of a wheel. At all events, the use of the lantern is the most characteristic feature in the gearing of the Middle Ages.

Several examples of gearing are included in a military engineering book, the author of which is unknown but which probably dates from about 1430. An interesting but rather grotesque sketch, Fig. 4, represents a wheel with saw teeth on its face geared to an endless screw, and used for the purpose of winding a bucket up from a well.

Another picture of the same date represents a wind mill with a pinwheel and lantern arrangement for grinding grain. A third sketch shows a shaft with cams to lift and let fall pestles for the purpose of pounding saltpeter. Gearing is also pictured on a boat with paddle wheels, but while the paddle wheels in this are interesting, the gearing is not very clear.

Da Vinci's Sketch of Gearing

Among the numerous sketches by Leonardo da Vinci, which are apparently of even more interest today than at the time they were produced, are several illustrating types of gearing. One is of a number of wheels with different sorts of cogs among which is probably the earliest known sketch of a wheel with cogs inside the rim. Here the teeth are of triangular shape, with one side nearly parallel to the radius.

Another of Leonardo's designs shows a gear turned by a water turbine, and used for drawing flat iron rods while they were rolled by another wheel.

Gearing with toothed wheels was also sketched by Leonardo in a press, a crane, a boring machine, and a file cutter. It was ilkewise employed in a road measurer and paddle boat, which were perhaps suggested by the description of Vitruvius already noted. The designs of Leonardo were of course more or less suggestions, and but few of them were ever put into actual practice.

Agricola's Gearing

About the middle of the sixteenth century, George Agricola, in his "De Re Metallica," described the gearing in use in his day, and probably for many years previous. The great majority of his gearing consists of lanterns with rundles combined with either spur or pinwheels. Fig. 5 shows his improved lantern and face wheel.

How a toothed wheel was constructed at that time is explained in Agricola's description of a machine for raising water by chains and dippers: "The teeth of each wheel are fastened in by means of screws, the threads of which are screwed into threads in the wheel, so that when teeth are broken they can be replaced by others. Both the teeth and rundles are made of steel."

Shop Kinks from the "Milwaukee" at Tacoma

By Fred H. Colvin
Editor, *American Machinist*

The shops of the Chicago, Milwaukee & St. Paul Railway at Tacoma, Wash., handle not only the steam equipment but also the huge electrical locomotives which now haul its trains over the two mountain ranges. This is developing a new kind of railway mechanic, for electrical connections are all important and a second's carelessness in making a joint may lay out an important train and cause heavy loss. The results, however, have been very gratifying and the men are as proud of the big electrical equipment as the officers. Steam locomotives still predominate, of course, but the electrical equipment is growing and the electric locomotives can barely be handled on a 105-ft. turntable. In common with nearly all railroad shops, the machine equipment is largely old and inadequate. It is kept up as well as may be and is clean and well painted. The great, and perhaps the only, advantage of inadequate equipment is that it develops ingenuity on the part of men and brings out devices which to a great extent overcome the handicaps imposed. A few of the kinks are shown herewith and others are to appear at a later date.

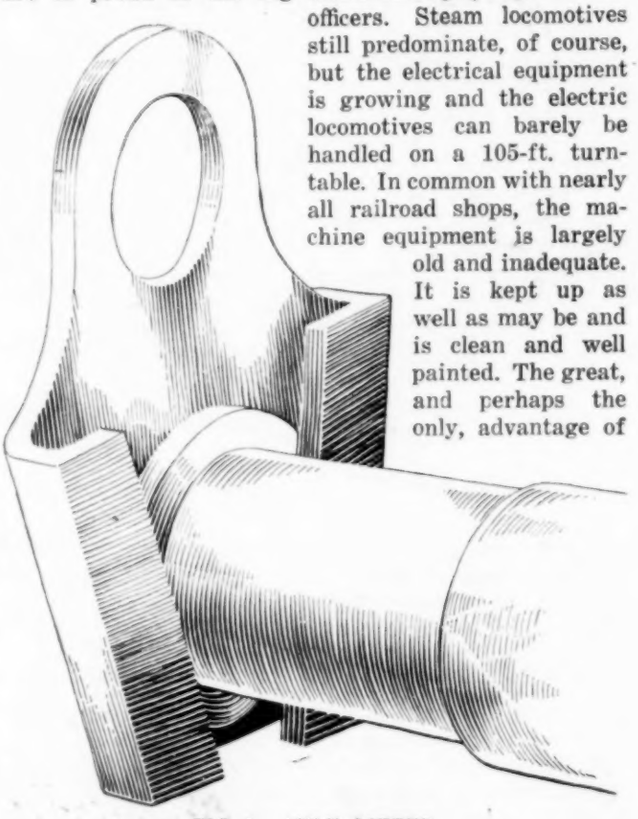


FIG. 1. AXLE LIFTER

Hook for Car Axles

For handling car axles in and out of the wheel press and elsewhere the hook or clamp shown in Fig. 1 is used. The collar on the end of the axle is utilized to prevent any possibility of slipping endwise. The lamp is a piece of flat stock, shaped and bent up to form the V-shaped pocket shown. This is simply hooked over the end of the axle, which tends to wedge itself in position, and holds it firmly against end slippage. These clamps cannot, of course, be used on collarless axles.

For planing or truing up crossheads after they have been overhauled the two supports *A* and *B*, Fig. 2, are used. They support the piston rod and clamp it in proper position during the planing. Turning the whole

rod assembly 180 deg. allows the other side of the crosshead to be planed parallel with the first.

The electric locomotives drive through a sort of spring connection, or shock absorber, as shown at *A*, Fig. 3. Heavy coil springs, mounted between suitable end blocks, transmit the power between gear and axles and take up part of the shock. Removing these springs

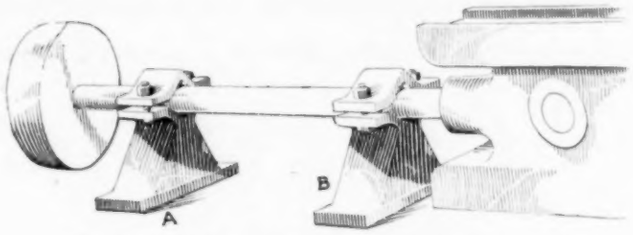


FIG. 2. FIXTURE FOR PLANING CROSSHEADS

is not an easy job without special tools and some are said to cut them out with an oxyacetylene torch, replacing them with new springs, as springs are easier to put in than to take out.

But the ingenuity of the railroad shop man got busy and made the tool shown in Fig. 3. The body *B* is a heavy piece of bar steel with a hole bored in each end to receive the pins *C* and *D*. These pins carry projections *E*, turned eccentrically to the bodies of the pins, and which fit into the holes in the blocks at the ends of the spring.

Turning the pins so these projections come in the right position, about as shown in the illustration, the projections are placed in the holes in the blocks. Then the pins are turned until the spring is compressed and can be easily removed.

The other end of the pin *C* has a place for a heavy wrench as at *F*, and is also provided with a ratchet and pawl at *G* to prevent the pin being turned by spring pressure. This is not usually needed but is an additional safeguard to prevent accidents.

Rod Length Gage

A rod length gage, which is always accessible and prevents mistakes and misunderstandings, is shown in Fig. 4, and is credited to general foreman Pentecost. Just who is responsible for the other devices is not a matter of record.

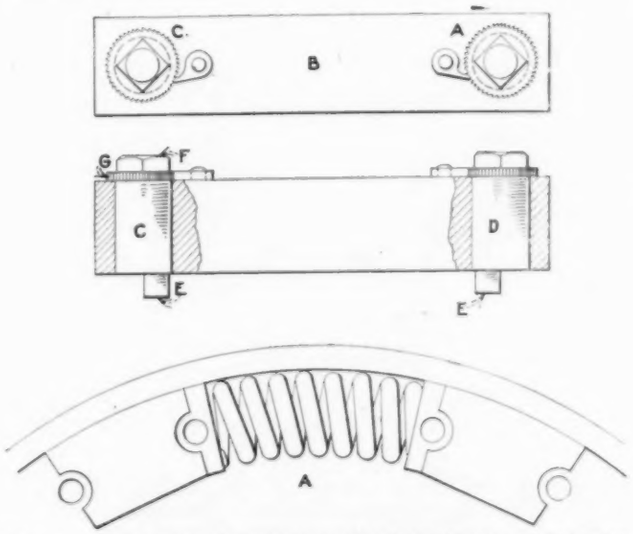


FIG. 3. TOOL FOR REMOVING SPRINGS FROM ELECTRIC LOCOMOTIVE WHEELS

This gage consists of a square steel bar *A*, about 2 in. on a side and perhaps 15 ft. long, mounted in three rollers *B*, *C* and *D*, which in turn are supported by three legs made of piping, suitably braced, and carrying the rollers as shown. The gage is about 4 ft.

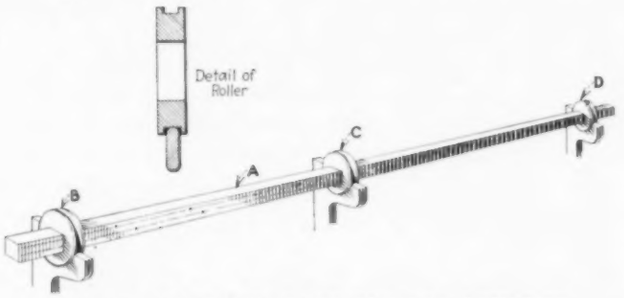


FIG. 4. STANDARD GAGE FOR ROD LENGTHS

above the floor so as to be easily inspected and used, and to keep it out of the way of dirt and damage.

The Graduations

The sides of the bar carry lines which are plainly marked at intervals to show the center distance of every connecting rod and every side rod used on the division. In addition, one side is graduated in inches from 44 to 80, to aid men on the tire lathes getting their sizes. These dimensions cover the range which comes in for repairs. The introduction of this gage has helped the men and also reduced the number of errors in laying out, and in boring and fitting rods and rod brasses.

The blacksmith shop is full of interesting devices, more of which will come later. These will show how machines are improvised and methods devised for making forgings at low cost.

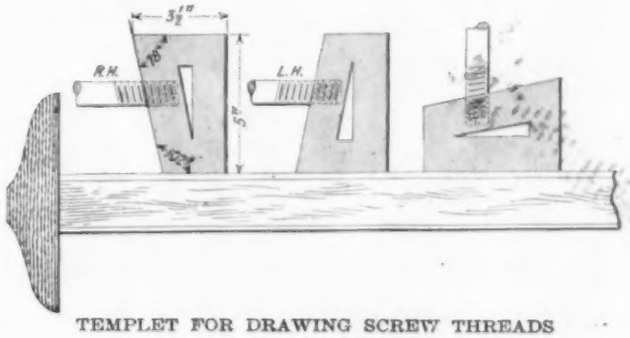
Drafting Room Kinks

By John J. Thompson

Regarding the suggestion of L. Weare, on page 564e of *American Machinist*, of a 12-deg. triangle for drawing screw threads; I would suggest for this purpose a templet made as shown in the sketch herewith.

As nearly all screw threads on drawings are right hand, it will be found that in using Mr. Weare's triangle that one must use the right-hand edge in drawing the threads on the horizontal view of a screw, thus bringing the short side of the angle against the T-square, where it will tip easily, as the base is not long enough to slide well.

With the templet shown herewith a long base is always against the T-square in any position and, being larger, it is easier to use.



TEMPLET FOR DRAWING SCREW THREADS

Calculation of Stresses in Winding-Drum Flanges

By JOHN S. WATTS

The strain imposed by the rope, on the flanges of a winding drum carrying a number of coils, is, generally speaking, much greater than one would expect, and frequent failures can be traced to a lack of appreciation of this strain by designers.

REFERRING to Fig. 1, the pull on the rope which is tangential to the drum as the rope is wound on, must be resisted by a radial force P, equal to the pull on the rope. For all coils after the first coil, the reaction P, is furnished by two component forces R, whose amount will be $\frac{P}{\sqrt{3}}$ each, the included angle between the resultants R being 60 degrees.

Referring now to Fig. 2, and assuming that the ropes in the inside coils are still under the original tension, it is obvious that the resultant force R on each rope is transmitted diagonally down through each coil, and that coil adds its own resultant to the preceding ones. The total force along line A will then be equal to $= 88 \times R$ the number of coils being nine, and the first coil not, of itself, exerting any side pressure.

It may be well to state here, that while it seems to be the consensus of opinion, that the inner coils must be relieved of at least a part of their original tension and that also, on the other hand, these inner coils have stiffness sufficient to carry a portion of the compression, and so relieve the drum of some part of the load. However, no authoritative tests have yet been made to determine just exactly what action takes place under the circumstances.

Personal knowledge of some failures of drums leads me to believe that, at any rate, a large percentage of the strain is actually carried by the drum, and the only safe plan is to assume that all of the coils are under the original tension, and that the resultant strain must not cause a stress in the drum casting in excess of the minimum breaking stress of the material.

In the example shown in Fig. 2 if the pull on the rope is uniform throughout the whole wind, the resultant diagonal force along the line A will $= 8 \times R$.

$$\text{But as } R = \frac{P}{\sqrt{3}}$$

$$\therefore A = \frac{8P}{\sqrt{3}}$$

This force A is in turn resolved into two forces, the horizontal one of which B is carried by the drum flange and as the angle between resultant B and force A is 60 deg. the resultant B will equal $\frac{A}{2}$.

$$\text{But } A = \frac{8P}{\sqrt{3}}$$

$$\therefore B = \frac{4P}{\sqrt{3}}$$

At B_2 we have the diagonal thrust of six coils, numbers 4 to 9 inclusive, which totals $\frac{6P}{\sqrt{3}}$ and as in this case the resultants of this force are at 60 deg. each side of the force, the resultant along B_2 due to these six coils equals the force $= \frac{6P}{\sqrt{3}}$. In addition to this we have the resultant from the rope next to the flange in coil 3, which is also equal to $\frac{P}{\sqrt{3}}$ making a total for B_2 of $\frac{7P}{\sqrt{3}}$.

From the same reasoning we have the horizontal reactions at

$$B_2 = \frac{5P}{\sqrt{3}},\ B_4 = \frac{3P}{\sqrt{3}},\ B_5 = \frac{P}{\sqrt{3}}$$

The total horizontal thrust against the drum flange will be

$$B + B_2 + B_3 + B_4 + B_5$$

$$= \frac{4P}{\sqrt{3}} + \frac{7P}{\sqrt{3}} + \frac{5P}{\sqrt{3}} + \frac{3P}{\sqrt{3}} + \frac{P}{\sqrt{3}} = \frac{20P}{\sqrt{3}} = 11.5P.$$

A sufficiently close approximation can be had with less calculation by counting all the ropes which exert pressure sideways against the flange, that is all ropes on or to the left of line A, in Fig. 2, except the one next to the shell of the drum in coil one. As each rope exerts a resultant force of $\frac{P}{\sqrt{3}}$ in a horizontal direction, and we have two ropes held up by the flanges, the total side pressure will be approximately $24 \times \frac{P}{\sqrt{3}} = 13.8\,P$, which is larger than the more correct method. A closer approximation would be to multiply $P \times$ half the number of ropes.

Taking this as being a uniformly increasing load, and the flange being regarded as a cantilever we have

$$\text{Bending moment} = \frac{13.8\ P \times L}{3}$$

or if we take the load as $P \times X$ where $X =$ half the number of ropes exerting pressure on the flanges, we get

$$\text{Bending moment} = \frac{x \times P \times L}{3}$$

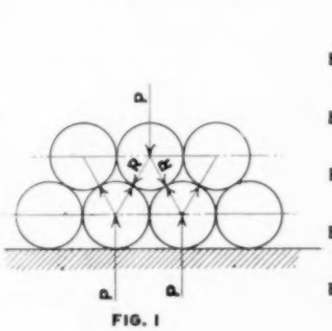


FIG. 1

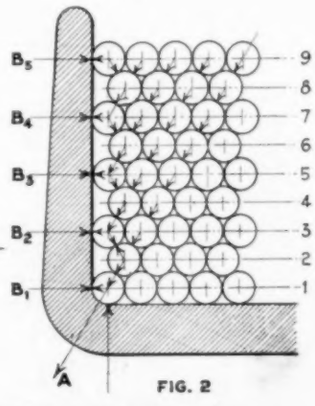


FIG. 2

FIG. 1. DIAGRAM SHOWING TANGENTIAL FORCES.
FIG. 2. DIAGRAM SHOWING RESULTANT FORCES TRANSMITTED DOWNWARD THROUGH EACH COIL

As the load will be practically uniform around the whole circumference of the drum, we take for calculation a strip of the drum flange one inch wide. The moment of resistance of this strip will $= fZ$.

Where f = safe working stress

Z = modulus of section $= \frac{bh^2}{6}$

$Mr = fz$

$\therefore = f \times \frac{bh^2}{6}$

But $b = 1$ in.

$\therefore Mr = \frac{f \times h^2}{6}$

$\therefore \frac{f \times h^2}{6} = \frac{x \times P \times L}{3}$

$N^2 = \frac{x \times P \times L}{2 \times f}$

As the load is gradually applied, taking the whole time of winding to rise from zero to its maximum, and as the calculated load is certainly in excess of the actual load, we may use a stress nearly equal to the breaking stress. Experience has shown that for cast iron as high as 15,000 lb. is safe provided that we are sure that the rope pull we have assumed will not be exceeded, and that the number of coils will not be increased because of uneven coiling.

When a large number of coils are to be wound on the drum, it will be necessary to rib the flange in order to gain the required strength, as the strain increases very rapidly with deep coiling.

Cam Cutting in A Jobbing Shop

By E. A. Dixie

An old Phœnix engine lathe which was fixed up many years ago as a cam cutter and which is still on the job is shown in Figs. 1, 2 and 3. Fig. 1 is looking toward the tailstock, Fig. 2 looking toward the headstock and Fig. 3 a view from the back of the lathe. The reference letters are the same in all figures.

The shaft *A*, Fig. 1, is driven by the spindle of the lathe. It is provided with universal joints and a sleeve so that it can follow the movements of the slide which carries the follower *B*, the latter being moved by the master cam *C*, seen in Fig. 2. The quill *D*, Fig. 1, carries the cutter and is provided with the usual thrust bearing. The lathe has a four-stepped cone which, with the back gears affords eight speeds for the cutter spindle. The wormwheel *E*, shown in all three views, is keyed upon the same shaft with the master cam and is driven by a worm on the shaft with the large pulley *F* which is belted from an independent countershaft.

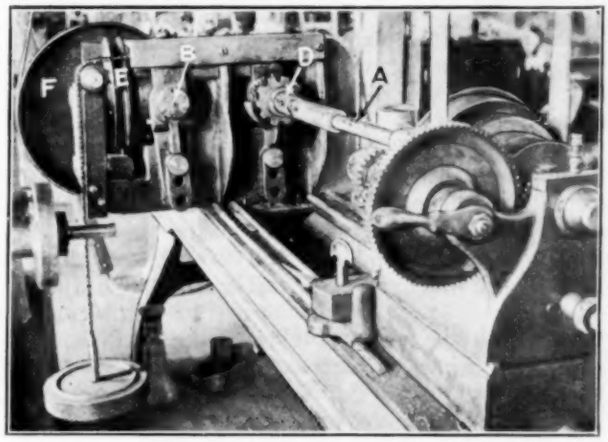


FIG. 1. VIEW OF CAM-CUTTING FIXTURE LOOKING TOWARD THE TAILSTOCK

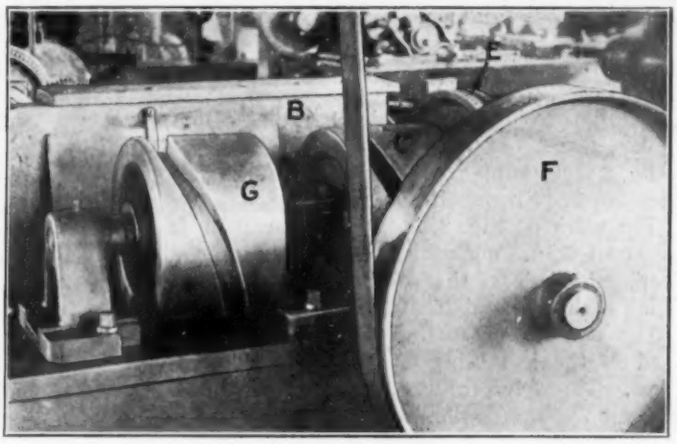


FIG. 2. VIEW LOOKING TOWARD THE HEADSTOCK

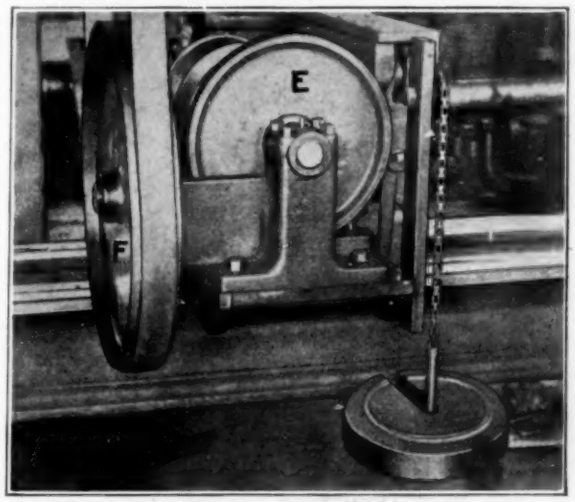


FIG. 3. VIEW FROM THE BACK OF THE LATHE

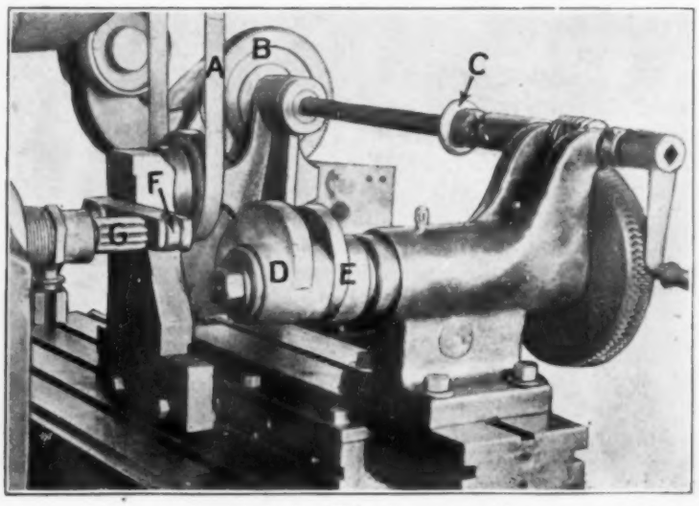


FIG. 4. SMALL CAM-CUTTING FIXTURE

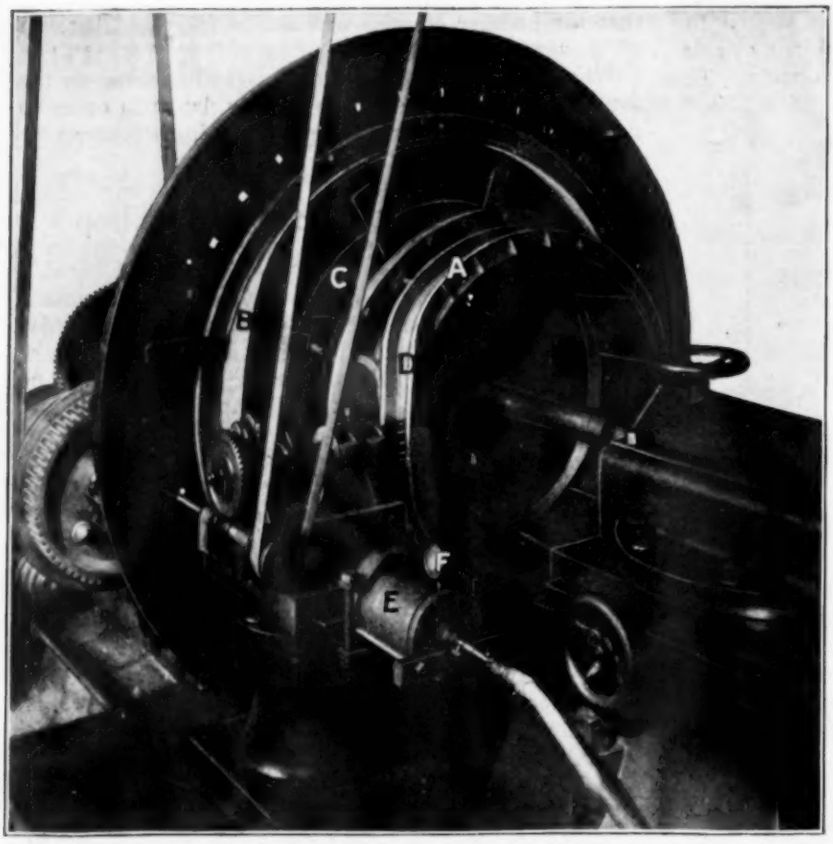


FIG. 5. CAM-CUTTING FIXTURE WITH AIR-OPERATED HOLDBACK

The fixture is heavy and looks to be out of proportion to the lathe. It is, however, self contained and the lathe merely supports it and drives the cutter, which does not require much power.

The work *G*, Fig. 2, is a drum cam 9 in. in diameter by about 6 in. long with a cam groove 1¼ in. wide and deep, milled from the solid. Two cuts were taken to finish each cam and 25 of them were cut in 30 hours.

The small cam cutting fixture shown in Fig. 4 is used on a plain milling machine for cutting a variety of cams. The drive for the work is from the belt *A* to a pulley on a shaft which carries a worm engaging with the wormwheel *B*. This is mounted on a shaft having a jaw clutch *C* which can be slid out of engagement so that the work spindle can be rotated by the crank handle. The work *D* and the master cam *E* are mounted side by by side, as shown. The follower roll *F* and the cutter *G*, mounted in the spindle of the milling machine, are approximately in line when the work is being machined.

Figs. 5 and 6 show a very interesting cam-cutting operation. The machine is a lathe built about 1856 and still in use. All the big cam-cutting is done upon it besides a great deal of turning, up to about 7 ft. in diameter.

A number of the large cams *A* were to be cut. The master cam *B* was made somewhat larger in diameter than the work. The cams were all faced and the bolt holes laid off and drilled. When all the cams were thus turned a fitting *C* was strapped to the lathe faceplate within the master cam. Its face was squared off and one of the cams bolted to it. The outside of the cam was then turned to the correct diameter and before removing it from the lathe the cam cutting attachment was placed in position and the cam groove *D* was cut.

A slow motion is provided for the lathe spindle when engaged on cam cutting. In the case shown the spindle speed was one turn in two and a half hours.

A rather unusual feature about this fixture is the holdback. There are no weights used but in their place the designer made use of an air cylinder *E* which is shown in both views. The shop has air service at 80 pounds. The air cylinder is 5 in. in diameter and is provided with a pressure gage *F* as shown, so that the operator can see at a glance how much pressure he has in the cylinder behind the piston. By throttling the inlet the air pressure in the cylinder can be regulated from zero up to nearly the full 80 lb. per square inch. Owing to slight leakage past the piston pressure regulation is possible, which would not be the case if the piston were perfectly air tight and no by-pass of the air were provided. The cam *A* is 48 in. in diameter and has a groove *D* 4 in. wide by 2 in. deep. When the follower *G* is "climbing" practically no air pressure is used, merely enough to keep the roll in contact with the master cam. When the follower is going "down hill" from 5 to 10 lb. of air is used which gives a pressure of from 100 to 200 lb. of the follower roll on the master cam face.

A talk with the operator elicited the fact that he had cut many kinds of cams on many varieties of machines, but that the air cylinder gave steadier pressure and less trouble than any of the others.

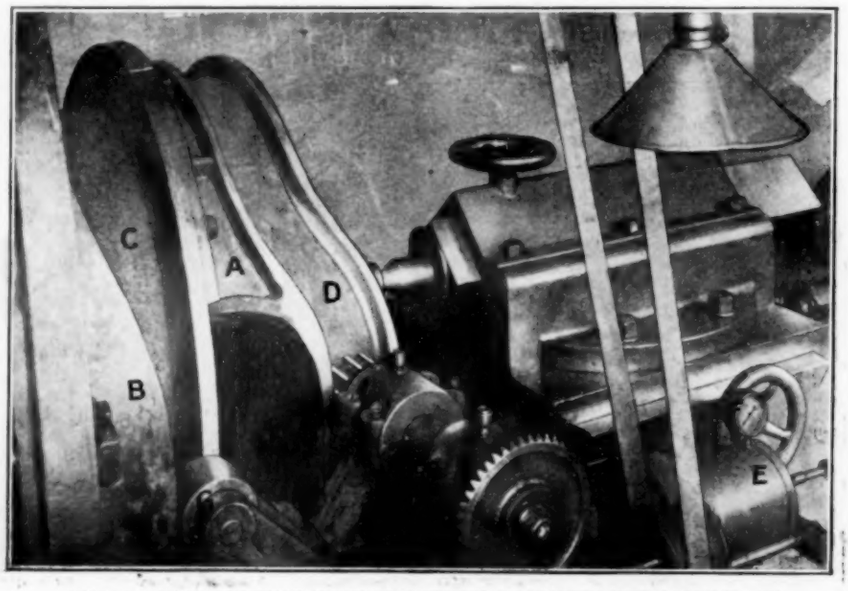


FIG. 5. CAM-CUTTING FIXTURE WITH AIR-OPERATED HOLDBACK

SEVEN CENTURIES of BRASS MAKING

By O. A. KENYON
ENGINEER RAY D LILLIBRIDGE, Inc.,
NEW YORK*

V. Sheet Brass—Extruded Rods and Wires

Here is taken up the production of sheet brass, which is made by rolling the cast iron bars, "an art that up to the present time has never been successfully divorced from the human element of the operator." The extrusion process of making rods and wires is also described. The information is presented chiefly by illustration, a method to which these subjects are well adapted.

(Part IV was published in the Dec. 2 issue.)

IN THE manufacture of sheet brass, bars are delivered from the electric casting shop to the rolling mills where the gates are cut off in an alligator shear as shown in Fig. 53. An expert examines the piece cut off to determine whether or not the cut is deep enough to eliminate the pipe. He is also able to judge the quality of the casting by examining the metal disclosed by the cut.

Having trimmed the bars, they are inserted into a breaking-down roll after which they are straightened by passing through a series of rolls as shown in Fig. 54. After being straightened, the surfaces of the casting are removed in a milling machine as shown in Fig. 55. This is done to remove mechanical flaws and surface impurities from the bar before rolling it to smaller sizes. The bars are now ready for another pass through the breaking-down rolls as shown in Fig. 56.

Since mechanical working of brass or copper hardens the metal, it is necessary to anneal it at various stages in the rolling process. In Fig. 57 is shown an annealing furnace from which an annealing charge has just been withdrawn. These furnaces are so arranged that the hard brass is drawn in at one end by the same operation by which the annealed brass is drawn out of the other. The temperature in these furnaces is accurately controlled by electric pyrometers, facilities being provided for reading

*Booklet published by the Bridgeport Brass Co., Bridgeport, Conn.

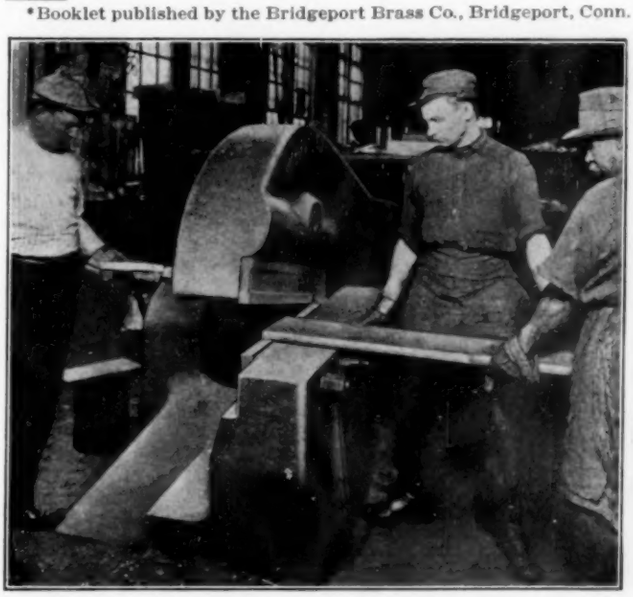


FIG. 53. BITING OFF THE GATE OF A BRASS BAR

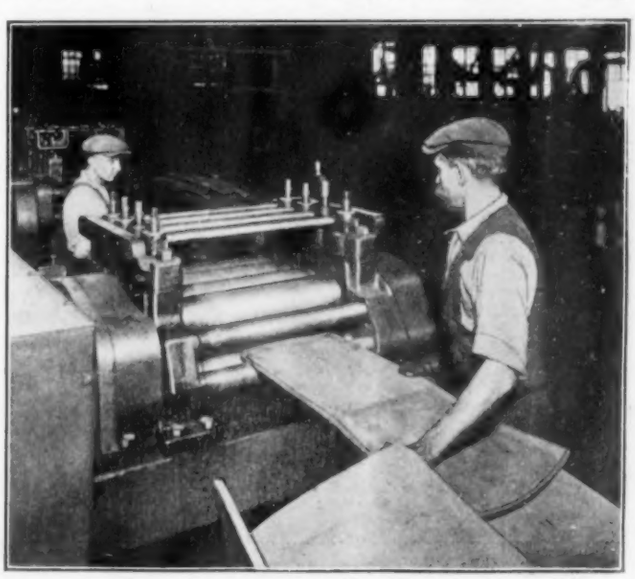


FIG. 54. STRAIGHTENING ROLLS

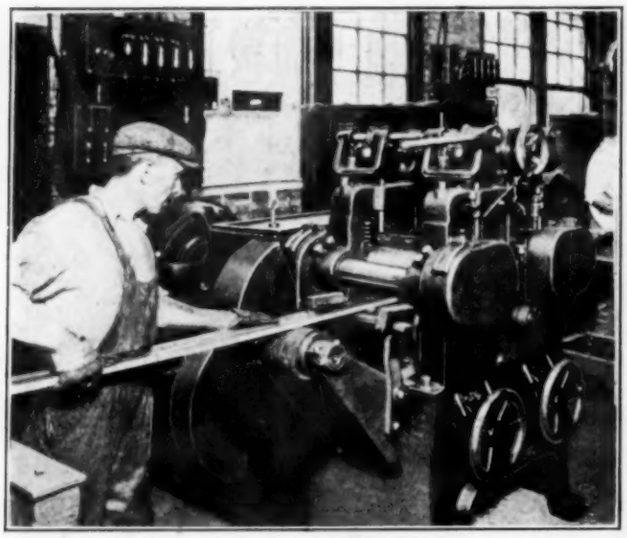


FIG. 55. MILLING THE SURFACE OF STRAIGHTENED BARS TO REMOVE MECHANICAL FLAWS AND SURFACE IMPURITIES

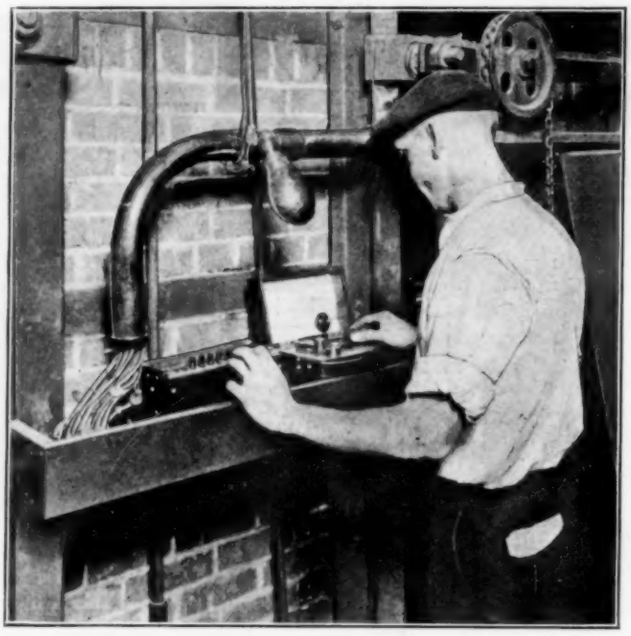


FIG. 58. TEMPERATURE INDICATOR

the temperatures at both ends and in the middle of the furnace. One of the indicating instruments is shown in Fig. 58. A recording pyrometer was previously shown, Fig. 45.

Some years ago the Bridgeport Brass Co. originated the practice of using tandem rolls in the production of sheet brass, and protected the process by a series of patents. Fig. 59 shows a set of these rolls in operation.

Rolling brass is an art that up to the present time has never been successfully divorced from the human element of the operator. The process as a whole can be planned and controlled according to a definite program but the rollers themselves must be men who have had thorough training and long practical experience. This company has been in the business since 1865 and has produced rollers who are second to none in the country. Several of these men have been with the company for more than 30 years and one man shown in Fig. 60 has been with them for 47 years. In Fig. 61 is illustrated the cold rolling of copper sheets.

Sheet brass is marketed in various forms, depending upon the thickness of the metal and also upon the purpose for which it is to be used. It may be in straight flat bars, in wide coiled strips, or in narrow coiled strips.

Rods and Wires—Extrusion Process

The Bridgeport Brass Co. uses the extrusion process for the manufacture of brass rods, while bronze, copper, and phono-electric rods are made by the rolling process as described in Part IV.

FIG. 56. MILLED BARS PASSING THROUGH THE BREAKING-DOWN ROLLS

FIG. 57. ANNEALING FURNACE FROM WHICH CHARGE HAS JUST BEEN WITHDRAWN

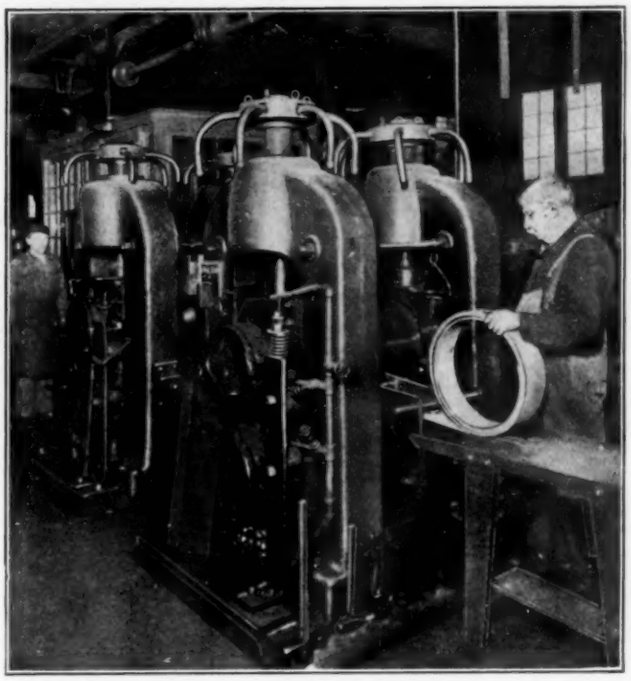


FIG. 59. A SET OF TANDEM RUNNING-DOWN ROLLS

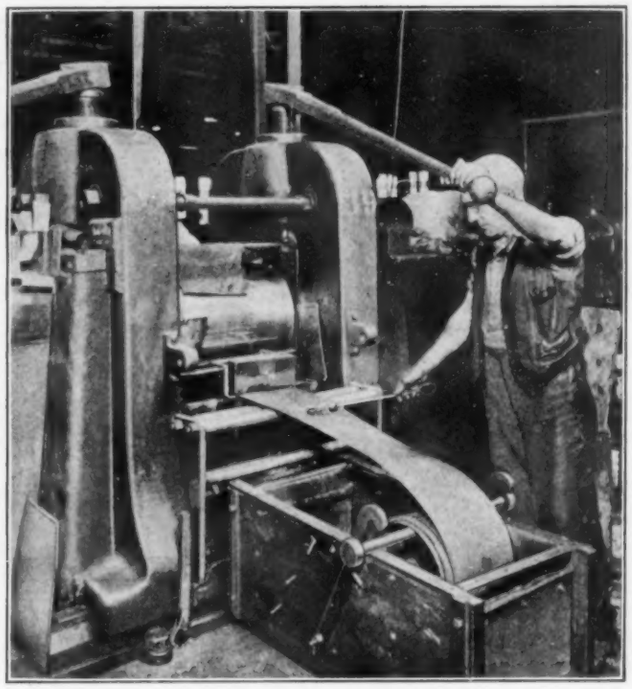


FIG. 60. ROLLING BRASS

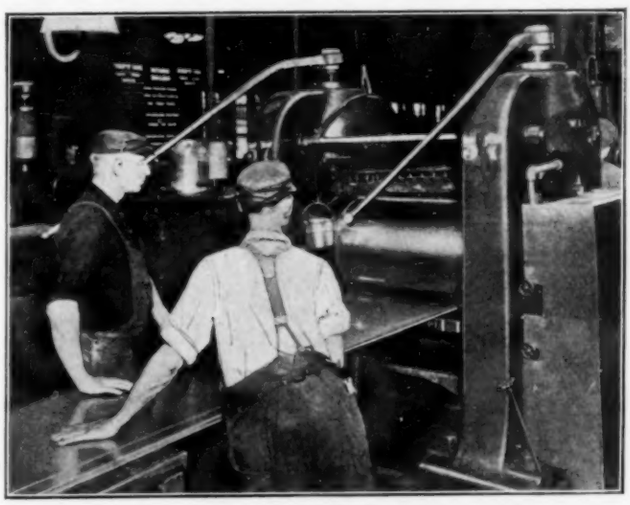


FIG. 61. COLD ROLLING COPPER SHEET

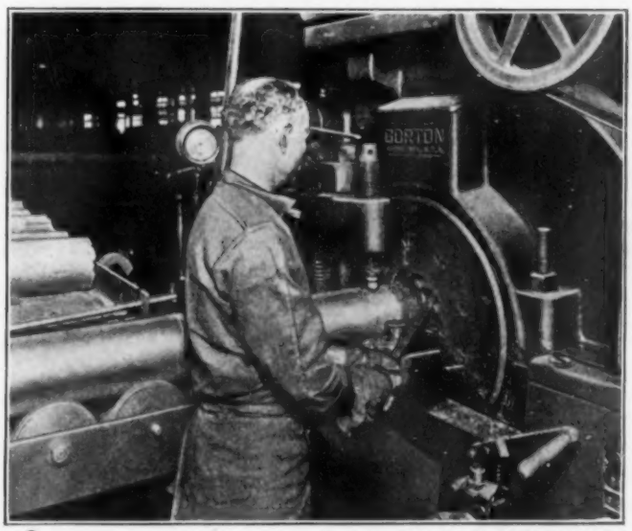


FIG. 62. SAWING OFF THE GATES OF BRASS BILLETS

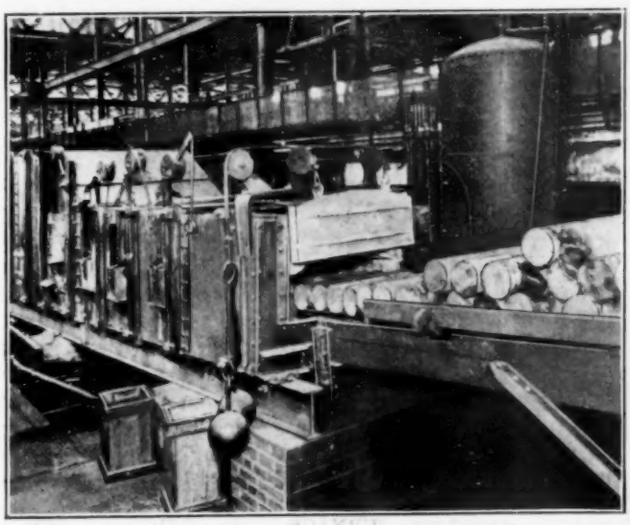


FIG. 63. BRASS BILLETS ON THEIR WAY INTO THE HEATING FURNACE OF THE EXTRUSION MACHINE

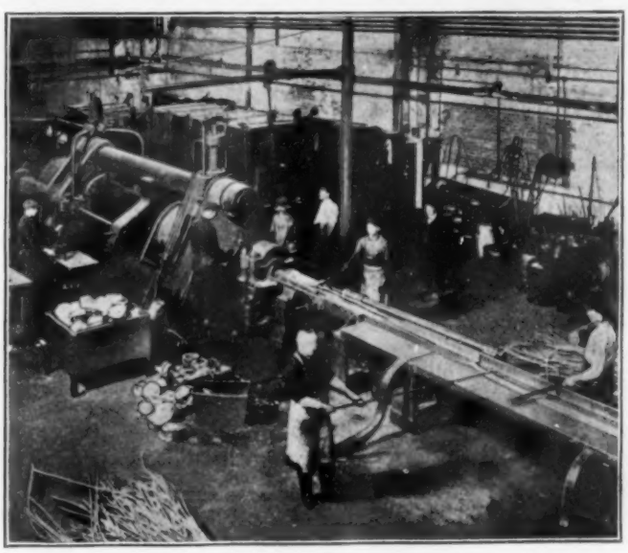


FIG. 64. THE EXTRUSION MACHINE IN OPERATION

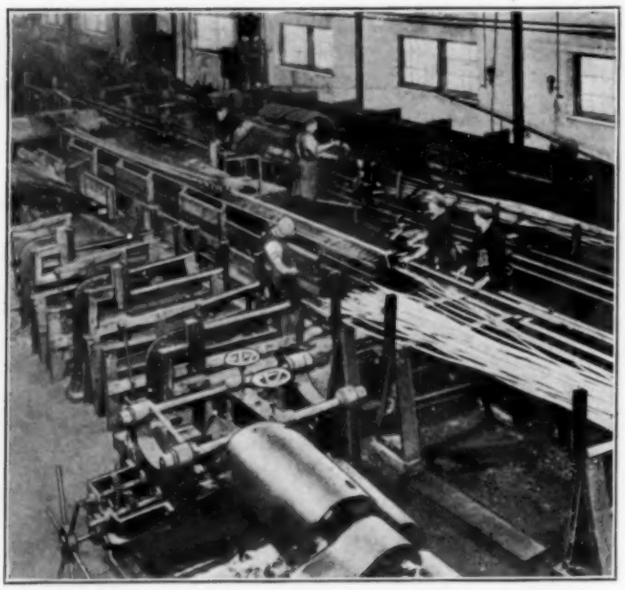


FIG. 65. DRAWING RODS FOR THE EXTRUSION MACHINE

The brass billets from the electric casting shop are delivered to the saws, one of which is shown in Fig. 62. From here they go to the heating furnace as shown in Fig. 63 where they are brought to such temperature as will render the metal plastic.

The plastic billet is then inserted into the cylinder of

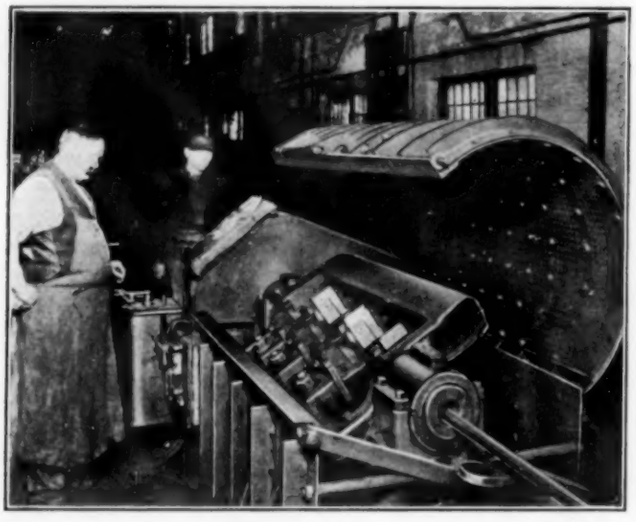


FIG. 66. STRAIGHTENING RODS BY PASSING THEM THROUGH THREE SETS OF SPIRALLY MOUNTED ROLLS

the extrusion machine and pressure applied to one end of it by means of an hydraulically operated plunger. The metal, being forced out through holes in a die at the other end of the cylinder, emerges from the machine as rods. In Fig. 64 the rods are seen coming from the machine and lying in the trough extending from its mouth. The cylindrical cakes in the center foreground are the ends of the billets removed from the machine after the main portion has been extruded. The muffle which feeds this machine is seen in the background at the right.

These rods are drawn to size and straightened for shipment, or wound on reels and delivered to the wire

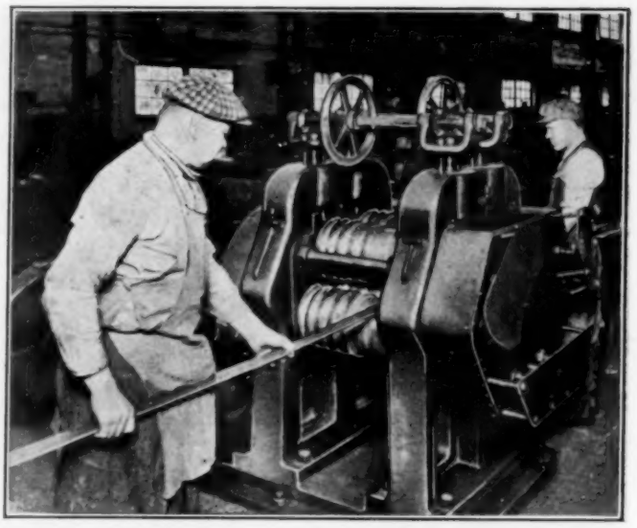


FIG. 67. SPRINGING MACHINE FOR REMOVING STRAINS FROM BARS AND RODS

mills where they are drawn to size in the draw blocks.

In Fig. 65 is shown the operation of drawing rods from the extrusion machine. This draw-bench operates on the endless chain principle, with reversing motors. Rods are straightened by passing them through three sets of spirally mounted rolls, which manipulate them in such a way as to relieve mechanical strains left by the drawing process. The cover of the machine, Fig. 66, is thrown up so as to show the method of mounting the rolls. In operation, the frame, containing the roll sets, rotates around the rod.

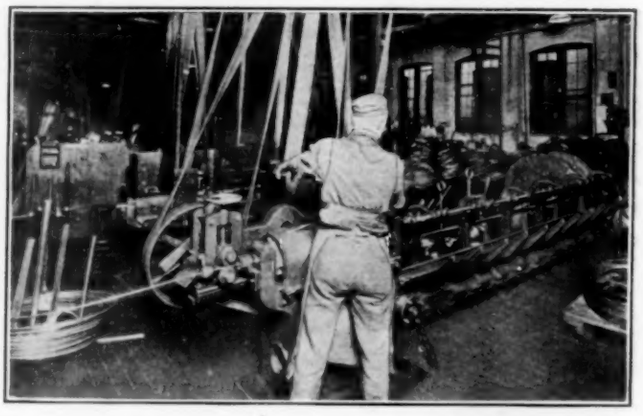


FIG. 68. STRAIGHTENING ROD OF SMALL DIAMETER

The matter of mechanical strains in drawn bars is of the greatest importance, since their elimination largely determines the service characteristics of the material. This detail of tube and rod manufacture has been scientifically studied by this company, and the manufacturing technique so worked out as to eliminate practically all unbalanced strains. This result is obtained by properly choosing the various factors that enter into the annealing, pickling, lubricating, drawing and straightening processes, all of which have a bearing on the strains in the metal. A springing machine for removing strains from bars and rods is shown by Fig. 67, and Fig. 68 shows the method of straightening rods of small diameter.

A Suggestion to Machine-Tool Builders

By T. F. GITHENS

The slogan of the modern successful manufacturer is "Service." The sale of a machine to a customer is only the beginning of the opportunities the seller has for selling his service to aid in the customer's business. The better the service received from the machine and the manufacturer, the more securely is the machine sold, and the more chances are there for obtaining additional business.

IN order to secure the most effective output from a machine, it must be given proper operating conditions and correct installation. The correct installation of a machine is the next important point to be considered by the buyer after the selection of the machine; in fact, quite often the selection of a given machine depends upon installation questions, such as the floor space occupied, the weight, and how the machine is to be driven.

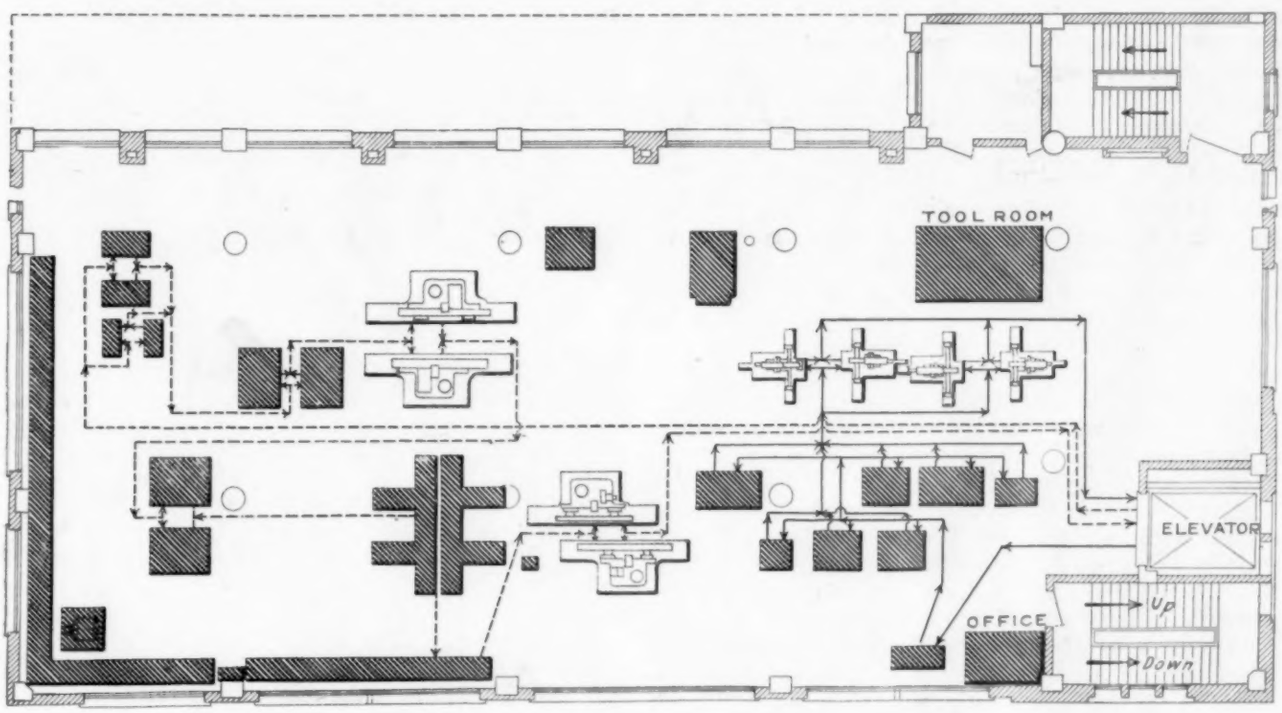
In making the layout of a new factory department, the approved method is to make a plan of the building to some convenient scale. For average size buildings, it has been found that a scale of ¼ in. per foot is the size which will give a plan covering a suitable size drawing sheet, 26 x 40 in. Windows, doors, columns, radiators, piping, and other stationary details must be shown to scale in their proper places, as they often interfere with or determine a layout.

The next step is then to cut out pieces of cardboard representing the floor plans of the different machines to the same scale as the building plan. These cardboards are then placed on the room plan in their most efficient combinations. It is usually most economical to have the product follow a straight line routing and move from one machine directly to the next operation machine, having these machines as near to each other as possible. This straight line routing will save enormously on the cost of trucking work from operation to operation and will reduce the quantity of stock in progress through the factory, and in many cases save money by reducing the amount of money paid out as interest on investment due to having valuable stock in transit through the works in larger quantities than necessary.

The location of the machinery is influenced by another factor than that of the most economical routing, namely: the method of driving. Machines driven by individual motors may in most cases be placed independent of this factor, but for most plants it has been found most economical to run machines by the "group drive" method, one motor driving a line shaft and this in turn driving several machines, from two to thirty. Machines which are "direct driven" should be located under the line shaft or a jack shaft to eliminate the expense of a countershaft. Machines requiring countershafting must be placed so that their drive pulleys on the line shaft will not interfere and so that where more than one row of machines is driven from a line shaft all the pulleys and belts will be given sufficient clearance.

This locating of the countershafting is an important and difficult question, and the only way to answer it so as to be sure that pulleys, hanger boxes and couplings are all correctly located is to make a detailed layout to scale.

It is right here that the writer wishes to bring home the point of his suggestions. The time and labor of making this detailed layout, and the shifting of one machine base here and a countershaft there, would all



PHOTOSTAT OF MACHINE LAYOUT

be saved *if the manufacturer would send out* with his machine, or his machine description, upon request, *a brown print showing the floor plan and countershaft plan* (where a countershaft is required) *to a scale of ¼-in. per foot.*

The customer could make a print from this brown print, cut around the outlines of the machine, paste it on cardboard for ease in handling, and have a far superior representation of the machine to a scale than a mere cardboard outline. These "cardboard machines" can be placed on the floor plan and clearances between machines accurately seen. The prints of the countershafting can be pasted on cardboard and their best location determined so as to most efficiently locate all the pulleys on the main line shaft.

Photostat Brought Into Use

When the small cardboard prints of machines have all been located to the satisfaction of all concerned, they can be pinned to a print of the floor plan held on a regular drawing board and a photostat made of the layout. This photostat can be made to any convenient size, such as ⅛, ¼, or ½ in. per foot.

These photostats will have three main uses:

(1) The engineering department can use them for designing structural work and the planking for holding countershafting to the ceiling. This is quite an item in concrete buildings, and one which must be considered in the design of the building. Materials must be ordered in advance for this purpose as well as pulleys for the line shafting. A machine may be delayed in being started because of lack of information concerning countershaft speeds and pulley dimensions.

(2) A photostat can be given the millwright and is a valuable aid in instructing him regarding the correct location of each machine which may be numbered or otherwise identified.

(3) A photostat is useful to the foreman, who will operate the department, and the production superintendent, as it will enable them to visualize the machines in a department and give them concise information of machine location, number, type, size, and appearance. It will also, when the routing for various products is drawn in different colored inks, show up the efficiency or weak spots as the case may be, in the handling of material from machine to machine.

In factories where there are many departments, it would be awkward and expensive to store away a drawing board for each department showing the machine cardboards pinned on a print of the floor plan. Therefore, when a layout has been completed, all machines have been installed and there is no reason to believe there will be any extensive changing of the layout in the near future, the cardboards may be pasted to the print of the floor plan and all filed away in a drawer occupying no more space than an ordinary tracing, and capable of being reproduced for use any time by means of the photostat machine.

It may be noted that most manufacturers now send upon request excellent prints showing floor plans of their machines and countershafting, but the point is they are all to different scales such as 1, 1½ and 3 in. per foot, etc. They are also to scales which are too large for the purpose of the draftsman who has to make a layout of the machinery for a department or entire floor. Also, they are mostly blueprints which do not admit of reprinting as brown prints do.

In answer to these points, the writer suggests a "standardized" floor plan of machinery and countershafting which shall fulfill the following specifications:

(1) It must be to a scale of ¼ in. per foot.

(2) It must be a brown print capable of printing brown or blue line prints.

(3) It must show the machines in normal and also in extended positions.

(4) It must show the countershafting and machine plans and speeds so that they may be cut out independently and pasted on cardboards.

The illustration herewith is from a photostat made of a department according to the above scheme with the exception that it was not possible to obtain brown prints of machine layouts to required scale. The machine layouts shown were photostats from prints of 1 in. per foot scale. The cross-hatched rectangles are cardboards merely showing floor space already occupied by machines.

Tool-Setting Gage

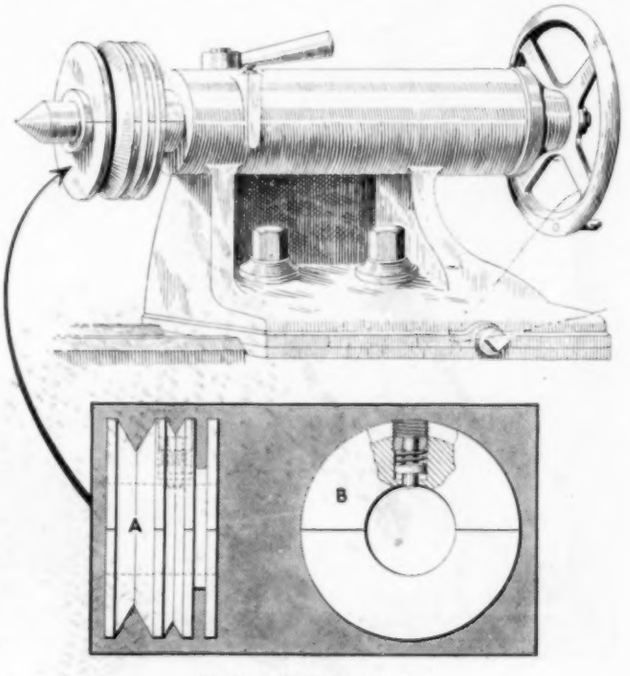
By Harry Moore

The drawing shows at *A* a ring I have made to facilitate the setting of lathe tools.

It is made of tool steel bored out to fit the tailstock spindle, turned, and cut with a large and small *V*; also grooved with a regular parting tool.

I have scribed a center line on the tailstock spindle; also the sides and periphery of ring. It is very convenient then to set a threading tool central to the line and in correct position at the same time, without having one hand tied by holding the thread center gage. The groove comes handy to set the parting tool central and square, thus eliminating guesswork and consequent binding. I set all my regular tools central by the line on the ring.

I made the ring plain at first but have since added an improvement in the shape of a spring plunger shown at *B*, which drops into a drill spot on the spindle and lines up the ring with the scribed line central.



TOOL-SETTING GAGE

A Mechanism for Graduating Dials of Optical Instruments

By J. V. HUNTER
Western Editor, *American Machinist*

The graduating of dials can be performed in various ways, the method used depending upon the character and amount of work to be done. The machine described here seems to be satisfactory for use on optical instruments, it being adaptable to work of different sizes and shapes where accuracy is important.

THE S. A. Rhodes Manufacturing Co., Chicago, Ill., had to overcome a number of difficulties in developing a machine for graduating the different styles of dials used in the construction of optical instruments. Samples of the many forms of dials which must be graduated are shown in Fig. 1. The work ranges from graduating the flange of the cup-like piece at the left of the illustration, to graduating the beveled portion of the disk at the right, or even the special knurling on the thumb-nut shown in the center.

The requirements of the work have been met by the construction of the special graduating instrument shown in Fig. 2. All parts of the machine are not new, for many were taken from old machine tools which were available when the device was constructed. The top of the plate A, which serves as a base, is carefully finished, and on it the dove-tailed base *B* of the spindle-head for

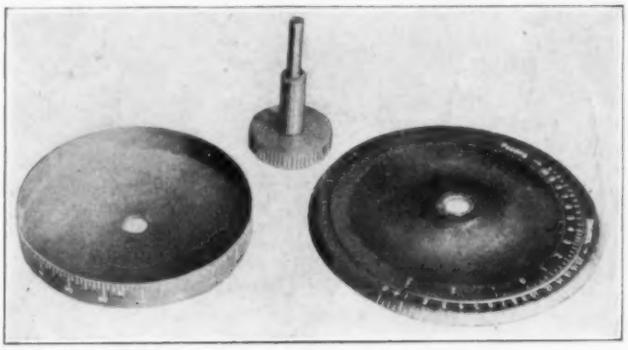


FIG. 1. SAMPLES OF WORK GRADUATED ON MACHINE

holding the work is fixed. The mechanism at the right carrying the engraving tool can be set and bolted in any one of several positions on the plate, so as to take care of the different forms of dials which have to be graduated.

Head for Holding the Work

The spindle head, Fig. 3, consists of the base *A* provided with two slides at right angles carrying the vertical upright and the slide *B*. The upright is provided with a graduated base *C* and may be swiveled to any

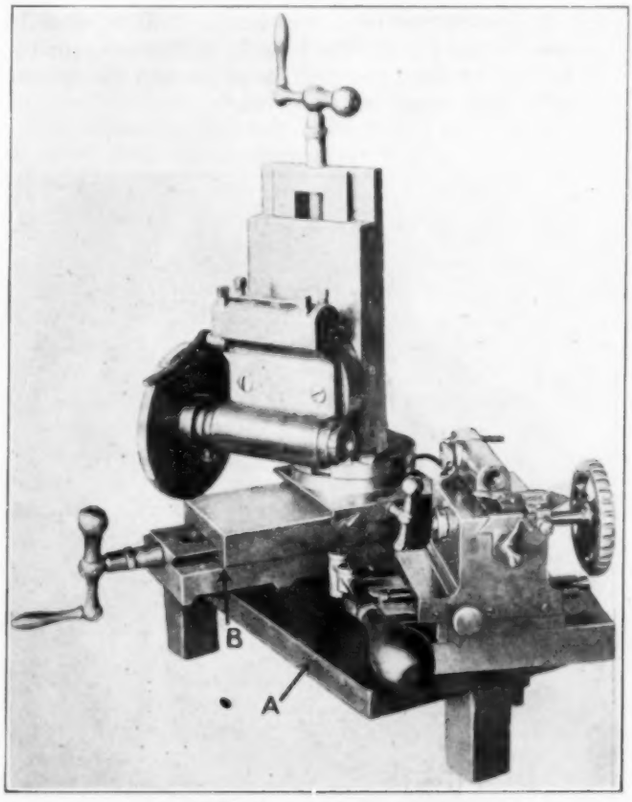


FIG. 2. A GRADUATING MACHINE FOR WORK ON INSTRUMENT DIALS

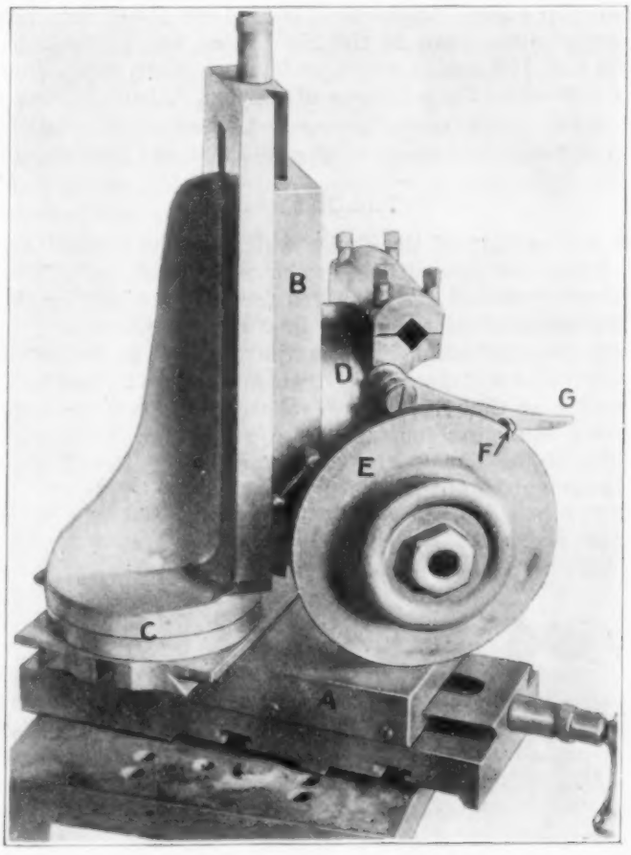


FIG. 3. ADJUSTABLE HEAD FOR HOLDING DIALS IN POSITION FOR GRADUATING

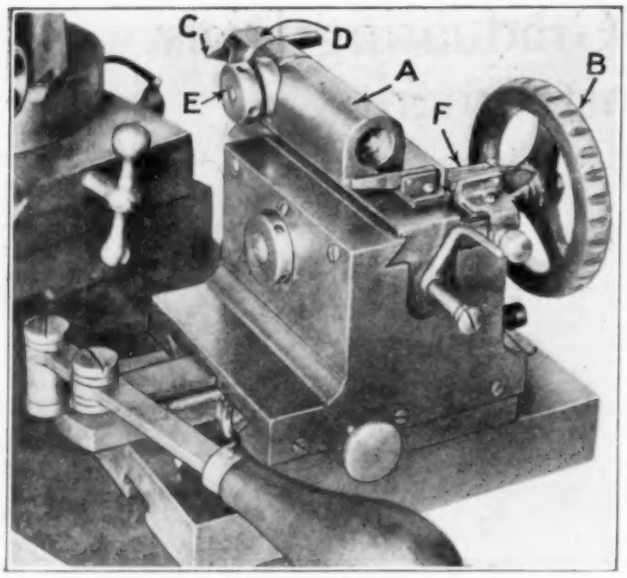


FIG. 4. HEAD FOR HOLDING RECIPROCATING TOOL

angle. The vertical slide *B* also holds a graduated base *D*, so that the spindle-head can be set at any angle with respect to the horizontal. The spindle has an index plate *E* to control its rotation, so that the desired spacing of graduations can be placed on the work.

The index plates or master graduating dials, such as the one shown at *E*, are made up in many cases for special series of graduations, although one dial is provided with angular graduations for the full 360 degrees. In other cases, the graduations are in the nature of those on a slide rule, and constantly vary in value as they run from zero up to the maximum. It will be noted that the special dial shown in the illustration has graduations for only 180 deg. of its circumference. Each graduation is marked on the periphery of the dial, and the indexing point *F* on the trigger *G* governs the amount of shifting of the spindle position after each mark has been cut on the work.

THE TOOLHEAD

The portion of the device which carries the tool for cutting the graduations is shown in detail in Fig. 4. The tool slide *A* can be moved forward and back by the handwheel *B* at the right, thus causing the tool *C* to cut the graduation lines in the work. The tool *C* is carried in a clapper-box *D*, which is held in place by a spring, so that the tool can relieve itself from the work when returning for each fresh graduation. The position of the tool in the toolpost can be adjusted after loosening the nut *E*.

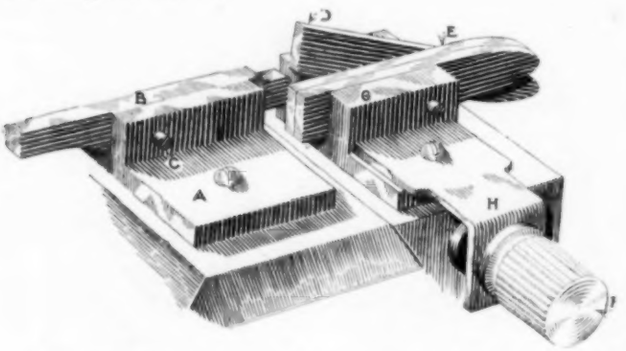


FIG. 5. STOPS ON TOOLHEAD USED FOR VARYING THE LENGTH OF THE GRADUATIONS

A means for limiting the length of the different graduations, so that every fifth or tenth cut, as is desired, may be indicated by a longer line, is obtained by the small device *F* which has been arranged on the rear of the housing of the toolslide. This device is more clearly indicated by the line drawing, Fig. 5. The small bracket *A* is fastened to the toolslide and carries an arm *B* which is pivoted at C. When it is not desired to use a stop for the toolslide the left-hand end of *B* can be tilted up, thus throwing down the extended portion at the right so that it passes beneath the plates *D* and *E* that serve as stops on the body of the toolhead. There are three of these stops, each approximately ☆ in. in thickness.

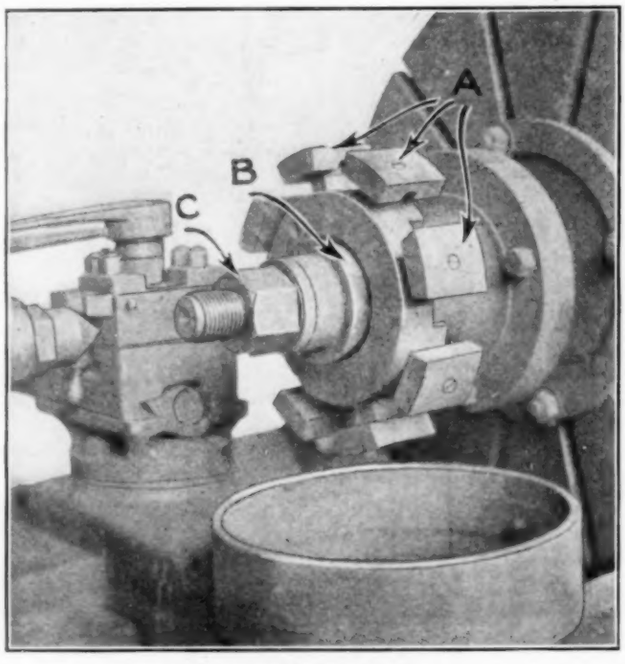
In the illustration the first stop *D* has been raised, thus permitting the slide to travel back a little further before the arm *B* strikes the stop *E*, and so make a longer line on the work. This stop would then be lowered and for the next four or nine strokes would serve to limit the graduated line to a shorter length. When a still longer stroke is desired for possibly a tenth division, both the stops *D* and *E* can be raised, letting the arm *B* come back against the last stop of the series. In order to adjust this device for proper position on different dials, the thumb-nut *F* is provided and connected to the stop bracket *G* by means of the angle *H*. This permits the stop to be set forward or back in order to place the graduations where they are wanted on the work.

An Expanding Chuck

BY E. A. THANTON

A very good chuck to be used where large castings must be chucked from the inside, is shown in the illustration.

The expanding jaws *A* are moved outward to the work by forcing the cone *B* inward. This is done by screwing in nut *C*. As the cone is withdrawn, springs at the back of the jaws pull them toward the center, making it easy to lift off the work.



AN EXPANDING CHUCK

The Law in Regard to Strikes—II

BY CHESLA C. SHERLOCK

This second article of the series treats of the legal liabilities, responsibilities and duties imposed on the employer by reason of a strike at his shop or plant. Just how the compensation and the common laws apply in these cases is clearly defined.

(The first installment was published last week.)

ASIDE from questions arising out of the right to work, the right of society to the uninterrupted enjoyment of the service of workers, which was treated in the previous discussion, there is another very important problem in regard to strikes particularly interesting to employers at this time. It is the legal liabilities, responsibilities and duties which a strike at his shop or plant imposes upon him. Must the employer, in case his workmen enter into a strike, refrain from the operation of his business until the workmen return? Must he refrain, under the law, from the importation and use of strikebreakers? In case of injury or death, either to the strikers or the strikebreakers, what is the employer's liability? Does the employer owe anything to a strikebreaker? Are professional strikebreakers to be considered as employees within the meaning of the law? Can the employer be sued for damages by a strikebreaker?

These are a few of the many perplexing questions which are bound to arise in any employer's mind just as soon as he finds a strike on his hands. And, oftentimes, a little previous knowledge on the subject will stand him in good stead.

The employer's liability to a strikebreaker for injuries must necessarily arise out of either (1) the common law, or (2) the workmen's compensation acts. If the basis of recovery under either of these two measures of the employer's liability be satisfied in a given state of facts, then the strikebreaker may recover for the injuries sustained.

THE COMPENSATION LAWS AS APPLIED TO STRIKES

The workmen's compensation acts, as everyone knows, places the employer's liability upon the basis of the relation of employees. Third persons have no right of action against the employer under these acts. Injuries, as they generally arise in the case of strikes, are caused by the strikers seeking to prevent strikebreakers from carrying on the employer's business or trade.

Unquestionably, a strikebreaker is an employee and entitled to relief under the compensation acts in the majority of cases. In fact, the strikebreaker and the employer usually recognize the hazards and some extra stipulation is made in the contract of employment seeking to compensate the strikebreaker in some specified sum in case of injury.

There is a provision in the compensation acts, however, which states that if the employee is injured as the result of a wilful attempt on the part of another employee to cause injury, then the employer shall not be liable for the payment of compensation. If a striker hurls a brick through the factory window with a malicious intent to injure a strikebreaker, is the striker still an "employee" within the meaning of the Acts sufficient to deprive the injured strikebreaker of his right to compensation?

It is problematical as to what the courts would say upon this proposition, but if we analyze the matter carefully we cannot fail to agree that when the Acts were written this proviso was not inserted with the subject matter of strikes in mind, but rather with the matter of private disputes between employees in mind.

The common wording is: "No compensation under this act shall be allowed for an injury caused by the employee's wilful intention to injure himself or to wilfully injure another."

Injuries, in order to be compensated under the compensation acts, must arise out of and in the course of the employee's work. An injury to a strikebreaker caused by the violence of a striker, when such strikebreaker is busy in his employer's place of business, unquestionably arises out of such employee's work. We do not feel that the courts, especially in view of the present temper of public opinion, would feel disposed to hold that a striker was still an employee in a sense sufficient to deprive the strikebreaker of compensation relief. Indeed, if the ruling of the Federal Court in the Iowa case mentioned in the previous discussion should apply, the strikers could not be considered in any sense as employees, but as men who had severed all connection with the employer under their contracts of employment.

Where the strikebreaker was assaulted and injured while off the employer's premises, another situation and basis of liability would arise. An employer is not liable for injuries sustained by workmen while they are going to and from the place of work, except in two cases, under the workmen's compensation acts: (1) When, by the contract of employment, the employer must transport the workmen to and from work; (2) where the employment increases the normal "street hazards" experienced by others in the community.

We are again unprepared to say what the courts might do, especially in the latter instance, inasmuch as cases have not been reported touching on the proposition of whether employment as a strikebreaker increases the hazard sufficiently to afford protection under the compensation acts. We are inclined to think that the courts might be widely divided on this point.

In either of the above instances mentioned, if the courts were to hold that the employer was not liable under the workmen's compensation acts, he would not be entirely freed from liability. The injured man would still have recourse to the common law, and if he had a basis for action might sue the employer for damages.

WHAT THE COMMON LAW ALLOWS

The common law is much more strict than the workmen's compensation system and the chance of a strikebreaker recovering damages for injuries sustained would have to depend clearly upon the contract relations between him and his employer. If it depended merely upon the status of employment, the chance of the strikebreaker securing damages would be extremely remote, as in that case the injury would have to result from the negligence of the employer and if touched by any of the three "common law defenses" of assumption of

risk, contributory negligence or the negligence of fellow-servants, on the part of the employee, then the employer would not be liable.

But in cases where special contracts have been entered into by and between the employer and the strikebreaker, it seems to be the concensus of opinion that the employer must stand by his contracts and fulfill them. The strikebreaker, for instance, cannot be held to have assumed the risk of injury from strikers when he enters the employment and such has been the subject-matter of a special contract between the parties. If no contract has been made between the parties, other than a mere contract of employment, and the strikebreaker enters the employment having full knowledge of the situation, he may be held to have assumed the risk of injury.

At common law it is the duty of the employer to inform his employees of any facts which he may know which have any bearing on the work to be done that might prove dangerous to the workmen. The employer, by reason of his superior knowledge about the work and the special conditions applying to it does have this knowledge from time to time and if he fails to impart it to his employees, he cannot later be heard to say that the employees assumed the risk along such lines. If an employer has a strike at his shop or factory and engages a new force on ordinary contracts of employment and fails to tell them that there is a strike at his plant, then he cannot escape liability under the common law, in case some of the strikebreakers are injured, by saying that they assumed the risk of injury by going to work.

One cannot, even under the harsh common law, assume a risk of which he has no previous knowledge. Rather, the blame is placed upon the employer for failing to impart the benefits of his superior knowledge concerning conditions, tools, appliances, and the like, to the employee at the time he went to work.

Concerning Inducements to Strikebreakers

Everyone knows that it is exceedingly hard to obtain men to work at a plant where there is a strike in progress. This is not only due to the fact that union men will seldom "scab" or place themselves in counterposition to other union men, but because of the fact that strikers are generally dead in earnest and do not hesitate to go to long measures to enforce their demands upon the employer. They walk out, hoping to cripple the employer and prevent the turning of a wheel until he comes to a common understanding with them. They do not take kindly to efforts on the part of the employer to proceed as usual, and they do not hesitate, as a rule, to resort to violence, to intimidate, to "beat up" or forcibly eject those who do go to work for the employer.

The result is that under ordinary circumstances the employer cannot secure men to act as strikebreakers unless some sort of special inducement is held out to them. And that is why the courts will, first of all, look to the contract between the parties to ascertain what the basis of liability may be if the workers were injured.

The contract liability is the important liability and if the parties have specifically agreed upon a certain sum as the basis of recovery, the employer will not be permitted to escape payment, the agreement among the parties being considered by the courts as a proper basis of damage, unless other circumstances familiar under the law of contracts enter in.

But no contract liability, as we have pointed out before, can be binding upon the parties unless it is well grounded in the law, as found either in the statutes or the old common law. Special contracts may be entered into creating greater rights for strikebreakers than they would hold as mere employees, but we must not lose sight of the fact that these contracts must be made for a legal and legitimate purpose. If they are made for an illegal purpose, they will be void in the very beginning and the special rights recognized will perish and the workers operating under them will have no greater rights than those conferred upon ordinary employees. An employer will not be permitted by the law, even in a time of great stress and crisis, to hire men to "beat up" former employees on a strike or generally to do violence to them. The courts will countenance no such purpose.

Employers as a rule do not bother themselves so very much about the sorts of inducements held out to the men at the time they are seeking strikebreakers. The important thing just then in the mind of the employer is to get men to work and he does not particularly care what kind of an inducement is offered just so long as he can get them to work.

He has a tendency to minimize the danger and to feel that there will be no disastrous results, no violence, no injuries, no deaths. Oftentimes, he will go to unreasonable lengths to pacify the fears of timid men in order to get them to work. He may make unusual and lavish promises, simply because in his anxiety to get the plant operating again he loses sight of important considerations—the fact that he may be called upon to make good these promises in a court of law.

He may even resort to fraud and deceit. Anything, in his mind, will justify the end just then. But when the violence has taken place and the strikebreaker has been killed or seriously injured, then the matter has a very different complexion. The one thing that he wants to know and to know to a certainty is whether he is bound by the special contracts which he made and by the special inducements offered.

Liability of Employer for Injuries to Strikebreaker

A case arose in New York which offers a splendid example of what usually happens under such circumstances. It seems that an employer had entered into a contract with a workman employed as a strikebreaker in which he agreed to indemnify the man or his family in case he were injured or killed while at work in that capacity.

The strikers succeeded in catching the strikebreaker one night and they used him so severely that he died. The family of the deceased promptly demanded the indemnity which the employer had promised under his agreement. The employer evidentally had a fair knowledge of law, for he refused payment, claiming that he was not legally liable.

The matter went to the courts and the court looked first to the contract, then turned back to the common law to ascertain whether such a subject-matter could properly be the subject of a contract between employer and employee. It was found that there was no such thing as a strike in the common law. It recognized no such situation or that a binding contract could be entered into on such a subject-matter. The court then said that if the contract was to be binding that it would have to arise under a statutory right; in other

words, there would have to be a special statute recognizing that such a situation would legalize any special measure of liability mentioned in the contract. Since there was no such statute on the books, then the contract failed and the employer was held not liable.

It was found, however, that there was a statute under which the employer was liable for the death of a workman caused by the employer's negligence. Since the death of the workman in this case was clearly not the result of the employer's negligence, the case did not apply.

Employers who, having a knowledge of the law and their measure of liability, enter into an agreement with a workman to act as a strikebreaker, knowing all the time that they can never be held to pay the indemnity in case it is called for, cannot be too severely censured. They are, in fact, leading innocent men to their death; certainly, they are laying them open to violence and injury under a false assumption of facts.

If the employer deliberately sets about to do this, and his intention can be proved, he will not fare so well in court. In fact, he may find himself being tripped up, rather than the reverse being the case. Deceit and fraud are never countenanced by the courts and they will oftentimes override precedents and established rules of procedure in order to bring an offender to terms.

One of the most common forms of deceit under these cases is to hire workmen from remote localities as strikebreakers, but not to acquaint them with the true situation. Nothing is said about a strike being in progress and it is figured that after the workmen come to the plant, often without means, they will continue at work even after they know the true facts, in order to earn money to get away.

Such a case arose in a Western state. A man was hired by the employer and put to work. He did not know there was a strike in progress. Nothing was said or done to acquaint him with the facts. A few days later while he was at work he was fired upon by the strikers and severely injured.

The court said that no employer had a right to hire a man and fail to acquaint him with the fact that a strike was in progress; that if the employer had a knowledge of facts or circumstances affecting the safety of the employee that it was his duty to impart that knowledge to the employee at the earliest possible moment. Failing in that, his concealment operated as fraud and deceit upon the unsuspecting workman and that was sufficient to render the employer liable in damages for the injury received.

Another leading case, turning upon a slightly different state of facts, is often cited to chart the employer's liability in such instances. It seems that a workman was hired by an employer who failed to say that there was a strike in progress at the plant.

A few days after the man went to work a committee of strikers waited upon him and acquainted him with the fact that a strike was in progress and stated that they could not permit him to work at the plant. They further warned that if he continued to work there would, in all probability, be violence.

The workman immediately went to the employer and told him what had taken place. The employer endeavored to persuade the man there was no danger and even promised to provide a guard for him if he would continue at work. Upon this promise, the man went back to work, but the employer failed to provide a guard. The result was that a few nights later the strikers caught him at his home and gave him such a slugging that he died.

The dependents of the deceased immediately brought action relying on two facts: (1) That the employer had failed to tell the deceased that there was a strike in progress at the plant, and (2) had failed to provide a guard in accordance with his agreement.

The court examined the statutes and stated that there was nothing in them permitting one to bring an action against another due to his negligence or wrongful act for death. So the family of the deceased could not recover against the employer.

The majority of instances where the employer will be liable for injuries caused by strikers must, of necessity, arise under rights conferred by the statutes. The common law, as a general proposition, is silent on the subject of strikes, they being unknown to it. But out of ordinary relationships of employment, a liability may arise under the common law, as we have already indicated.

But there is no liability on the part of an employer, as a rule, for damages for the death of a strikebreaker. The reason why the statutes have not conferred this right to third parties is due to the feeling that it would be against public policy to permit the death of another to become subject-matter for an action for damages.

Where the employer practices fraud and deceit, however, under a contract of employment, the courts have granted relief to the dependents of injured strikebreakers as they cannot countenance any such action on the part of employers.

So far as the workmen's compensation acts are concerned, they are statutes conferring a right for compensation for the death of a workman but under certain limitations. The decedent must have met his death by reason of an "accident" arising out of and in the course of the employment.

An English case has held that where a strikebreaker is injured by strikers that his injury is not an "accident" within the meaning of the compensation acts. This decision, however, implies certain facts which would not cover all cases. It implies that the workman was injured while going to and from work and not while on the employer's premises; further that the workman had knowledge of the fact that there was a strike in progress and that there was no fraud or deceit on the part of the employer. It does not apply to instances where the workman is injured while at work on the employer's premises.

Moral Obligations of Employers

In conclusion, we cannot help but call attention to the moral obligation which attaches to the employer in these cases. The employer should not be encouraged to study the legal situations arising under this subject for the purpose of finding out where he may invoke the protection of the law to work hardship and misunderstanding upon his employees, even though they be strikebreakers.

There is a moral obligation upon every employer which is growing stronger as the days go by, and that moral obligation has impelled employers to do things they never did under the common law. Our recreation centers, our model housing, our special educational measures and Americanization projects which we are witnessing in the industrial world every day, are the result

of a growing moral obligation which has eventually found its way into the laws of the land.

Public opinion is needed to solve the industrial tangle. It cannot react to the benefit of all classes, particularly to the benefit of the employer, if he is to continually keep merely the letter of the law and shirk the spirit thereof in these matters. So long as the employer takes advantage of the men he employs and fails to meet his agreements when they meet death or violence, merely because the law permits him to escape in the majority of cases, so long will he find himself at odds with the laboring classes and with the public.

Strikes and walkouts present a trying problem, none the less to the courts than to the employer. In the past the courts have sought to wash their hands of the matter in so far as possible. Public opinion is forcing a change. And it must also force better behavior from all parties concerned. Indeed, it will, if a real adjustment is to come.

Precision Gages

BY H. F. IRONS

The article by M. E. Kenek on page 884 of *American Machinist*, entitled "Precision Gages," contains some statements which in my judgment are misleading.

For instance, near the bottom of first column on page 885 the author refers to "the fact that all makers of gages . . . have settled upon an alloy having 1.35 per cent chromium and 1.0 per cent carbon." It may be of interest to know that analyses of several different Johansson gages of recent delivery show no chromium. The analysis of at least one block made by the Bureau of Standards two years ago (of which analysis the writer has a copy), also shows no chromium. I may perhaps be permitted to express a doubt that steel containing not more than one per cent carbon can be made hard enough to give satisfactory service in a gage block.

In suggesting a set of thirty blocks in which the odd thousandths and ten-thousandths are built upon the 0.010 base instead of on the 0.100 base as in the 81-block sets, the author says "this set can be made for half the cost of the 81-block set." It is my belief that it could not be made for twice the cost of an 81-block set because of the extreme difficulty in lapping gages as thin as 0.010 in. Aside from the difficulty in lapping these very thin sizes without causing them to curl from the peening action of the laps, the author himself makes the illuminating statement in the third paragraph, second column, page 885, "with thin flat gages there will be found after a very few days a noticeable convexity on the sides of largest area."

After all manufacturing and seasoning difficulties had been overcome, there would remain the flexibility which, in the hands of the user, makes these thin blocks difficult to handle and to keep flat.

The author's statement at the top of the last column, page 885, "from this it would appear that the aging process seems to affect hard gages more permanently than the softer ones" seems to be based on his preceding statement that he has seen one hard gage which was permanent. I doubt if this proof will be accepted as conclusive.

Mr. Kenek in his article refers quite justly to the difficulty in setting to exact parallelism the two plugs at opposite ends of a stack of gage blocks when used for measuring holes.

The company with which I am connected has appreciated and met this condition by making the end measuring attachments slightly wider than the gage blocks, and with two sides finished accurately parallel with the semi-cylindrical ends. Hence, by laying the stack of blocks on a surface plate, the measuring ends are easily made parallel. This is found more accurate than the channel for use in assembling stacks to which Mr. Kenek refers.

New Form of Industrial Insurance

A new form of group health and life insurance, which from present indications bids fair to outdo all other forms in popularity with workmen, has been established by the Life Extension Institute, Inc. This latest addition to industrial welfare associations is headed by ex-President Taft and its directors include some of the foremost figures in the technical life of the country.

What impresses us most about the insurance offered by this association is the group policy, in which the employer and the employee enter into the contract on a fifty-fifty basis, each paying one-half of the yearly payment, the working man getting the financial benefit and the employer getting better and steadier service as his dividend on the investment. Besides the regular sick benefit and life insurance there is another phase—health improvement. This provides physical examinations by competent doctors and the proper medical attention to correct an employee's affliction and restore him to his proper degree of efficiency.

As an example, by the payment of 25 cents a week each by employer and employee the latter is granted $1,000 life insurance, $10 a week benefit and accident insurance and the annual health service of the institute.

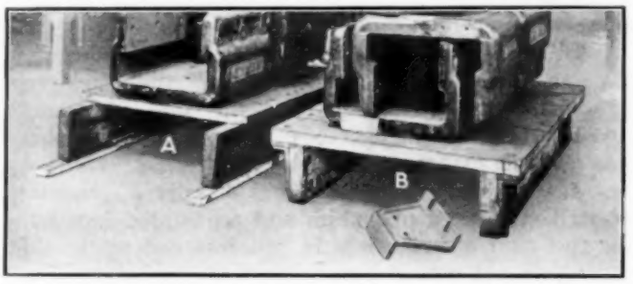
This is a somewhat different plan from most other industrial insurances because of the joint participation of both company and workman.

Restoring a Truck Platform

BY F. C. WOOD

Plant Engineer, Heald Machine Co.

A cause of failure in the ordinary truck platform is shown in the illustration at *A*. The wear and shrinkage of the side pieces soon makes it impossible to insert or remove a truck without blocking up, as shown; also



OLD AND IMPROVED TRUCK PLATFORMS

the end top boards are the first to become loose after which the platform soon becomes useless.

The remedy is shown at *B*. The cast-iron foot shown requires no machining and maintains the correct height and also holds the end boards which should be made of hard wood.

Foundations for Machinery*

By N. W. AKIMOFF

Vibrations arise either from lack of balance or from other causes. The proposed theory contemplates the latter, the problem of balancing being considered as capable of complete solution by suitable treatment. After briefly considering the nature of possible displacements of the foundation as acted upon by various causes leading to vibrations, the author introduces, by way of illustration, a double pendulum, a few experiments with which form the basis of his theory. Means for localizing the expected vibration and of controlling the resulting periods are then illustrated in a working sketch of the proposed arrangement.

THE weight of the Great Pyramid is approximately 5,274,000 tons, its base is 764 ft. square, and its height about 486 ft. It is built on leveled rock. The Washington Monument rests upon a bed of fine sand, 2 ft. thick. The piers of Brooklyn Bridge are founded 44 ft. below the bed of the river upon a layer of sand 2 ft. thick which rests upon bedrock. The massive St. Isaac's Cathedral, Petrograd, is built on a swamp, and the piling has been so carefully proportioned that the exceedingly heavy doors of the cathedral swing easily, whereas the slightest lack of uniformity in settling would doubtless lock them. These well-known structures are here mentioned by way of illustrating the obvious purpose of the foundations upon which they rest. The object of such foundations is double: (1) To distribute the load in as nearly uniform a manner as possible; and (2) to secure uniformity in settling, it being a well-known fact that all heavy structures settle, some to a considerable extent, 6 to 12 in. and sometimes even more.

Just how all this applies to foundations for all sorts of machinery, and in particular to rotative machinery, is not easy to say. Indeed, the weight, say, of a large pumping engine or of a turbo-generator outfit is generally much lower per square foot of floor space occupied than the limits prescribed by municipal laws or building ordinances, and furthermore, uniformity of settling of a relatively small volume of this nature (substructure plus engine, etc.) can be secured without going to the extremes usually observed in designing footings for buildings.

What, then would be the general governing idea in proportioning a foundation, say, for an engine of a given type? Should it be heavy or light? Should it be deep, resting on rock or sand if possible? Should it be independent of the footings of the building, or would it be desirable to tie it to the latter?

By examining the existing records we can find a great variety of rather contradictory answers to each question, but the predominant idea in the mind of the designers appears to be somewhat as follows: Since the engine is likely to vibrate, let us tie it as firmly as we can to the earth itself. The mass of the earth being practically infinite, the amplitude of the resulting vibration will probably be zero. The designer may be utterly unconscious of this reasoning, but he applies it through instinct or "horse sense" and gets results which sometimes are satisfactory and sometimes exceedingly poor.

It is especially interesting to see how the same designer, having decided to provide as solid a foundation as practical considerations allow, will often unconsciously neutralize his whole theory by such means as: (*a*) resting the foundation upon a layer of rubber, cork, felt, or other yielding material, as shown in Fig. 1, *A* and *B*; (*b*) providing a space between the foundation and the walls of the building and filling it with sand (if the foundation is so heavy and so deep as to secure immunity from vibrations, why fear its contact with the walls?); (*c*) using various pads, buffers, cushions, etc., see Fig. 1, *C* and *D*, which, if at all yielding, of course tear to the ground the very idea of solidity of the foundation with the earth.

Causes of Vibration

A rational basis on which to work is thus seen to be lacking and it is accordingly the object of this paper to point out some definite lines along which a rational theory of substructures for engines and moving machinery can in general be built up. To begin with, it is important to realize that vibrations are caused by two distinct orders of agencies: (1) Those due to unbalance, or, more correctly, lack of running balance; and (2) those due to causes other than unbalance.

As regards unbalance, it may be said that this can be so easily corrected in the construction of machinery that all specifications should invariably call for perfect running balance at all speeds, that is, complete absence of tremor or of "periods" under all conditions. The writer feels that such a complete practical solution of this problem of balancing has been offered by him for bodies of all kinds that there is now absolutely no excuse for the manufacture of unbalanced machinery. However, there are many causes quite independent of bal-

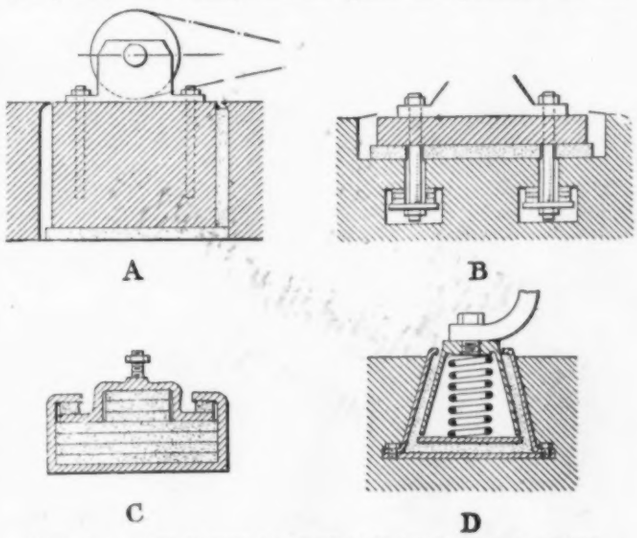


FIG. 1. SOME COMMON METHODS OF NEUTRALIZING VIBRATION

*Presented at the annual meeting, December 7-10, 1920, of The American Society of Mechanical Engineers, 29 West 39th St., New York City.

ance, each of which is likely to result in vibration, as for instance, "whipping" of a slender body (crankshaft, armature, turbine rotor, etc.); water in a steam turbine; peculiarities of the reciprocating mechanism—for instance, a 4-cylinder or an 8-cylinder V-type engine where certain forces do not cancel out and where running

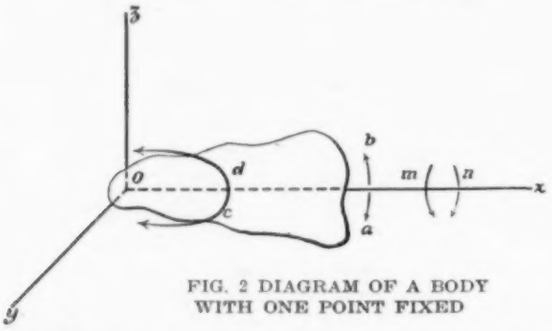


FIG. 2 DIAGRAM OF A BODY WITH ONE POINT FIXED

balance alone is not conducive to perfect results; or torsional vibrations, which under certain conditions produce an effect very similar to that of unbalance. Our problem, then, is to analyze the effect of these various causes, with the view of designing a substructure for a given machine that will be *least responsive* to these causes, for this is what the "relative" freedom from vibrations really means.

But whatever may be the cause of vibrations, it is safe to say that in general they are always due to *forces*, acting in a plane or planes, perpendicular to a certain axis; also to centrifugal *couples*, located in a plane, rotating about a certain line, usually the axis mentioned just above. We know from elementary mechanics that any motion of a body can be resolved into six distinctly separate motions: three *along* the three mutually perpendicular axes drawn through any point, within or without the body, and three *about* these same axes. A free body, capable of a displacement in any of these six modes, is said to possess six degrees of freedom.

Vibration as Affected by Degrees of Freedom

If the body is rigidly locked so that no displacement of any kind is possible, we say that all six degrees of freedom have been suppressed. By fixing two points in the body we have the effect of rotation about an axis, and only one degree of freedom, that is, the angular displacement about the axis, characterized by these two points. By fixing one point we suppress all bodily motion along any three axes through this point, but we still have three degrees of freedom, that is, freedom of angular displacement about any or all three axes. Fig. 2 shows a body whose point O is fixed. Such a body can have only three kinds of displacement: (1) about the axis y, as shown by the arrows a or b; (2) about the axis z, as shown by arrows c or d; and (3) about the axis x, as shown by arrows m or n. It makes absolutely no difference what the forces are which act on the body, no other motion is conceivable.

On the other hand, placing a body upon a thick sheet of yielding material, or for that matter on four springs, means freedom in all six directions; and of course the same applies to cushions or pads. For this reason it appears to be of extremely questionable value to interpose layers of such material between a massive subfoundation and the foundation proper of a machine, even if isolated examples are on record where such an arrangement actually *happened* to give satisfactory results.

With the foregoing in mind, let us digress for a moment. Stability with regard to our subject is a somewhat relative term. Why was the Great Pyramid built upon level rock, even, we are told, dovetailed therein? To insure stability. Why is a ship's compass or barometer mounted in gimbals? To secure stability. Why build a massive foundation for an engine? To secure stability. Why provide a layer of yielding material or springs or rubber pads? To secure stability. In other words, it is quite necessary to define in a more rational way the purpose of a foundation for an engine of a given type. We shall attempt to do this, first stating, however, the well-known effects of vibrations on various types of apparatus.

Effects of Vibration

In large power plants where the main units are of the modern turbo-generating type the steam mains have been known to burst, and subsequent investigation has often revealed no defect either in material or in general arrangement of piping. The accident can thus only be explained as due to "rough" running, that is, vibrations. What, then, would be the remedy? To anchor the unit still firmer, or place it on more yielding substance, thus encouraging the effect commonly known as "flopping around"?

The operation of a printing plant or of a leather-working factory is often extremely unpleasant for adjoining dwellings, and sometimes even for buildings located at a rather considerable distance. Inspection often reveals that machinery in such plants is firmly secured to extremely massive foundations, and the owners are at loss as to how to remedy the trouble.

Within the building itself, irrespective of the effects of neighboring properties, the action of machinery is often felt and has been known to cause a great deal of annoyance and dissatisfatcion. In addition to the printing press and the leather-surfacing machine, the types of machinery usually apt to cause trouble are as follows: triplex pumps, ice machines, air compressors (direct-driven), and various types of purely rotative machinery, such as blowers, centrifugal pumps, etc.

An internal-combustion engine often exhibits a certain amount of vibration which can be felt all over the understructure. In fact, owing to violent vibrations some of the tie rods, lamp brackets, etc., on automobiles have been known to snap in two, and in aircraft some of the instruments to drop off the board, yet these were parts of the understructure, to which they, as well as the engine itself, were firmly secured. The point we wish to emphasize is that in an understructure too much rigidity is as harmful as too much freedom to yield.

Stability Defined

We are now ready to formulate the new criterion of "stability" for foundations. Stability is here characterized by remoteness of the operative speed from any one of the several synchronous speeds at which the frequency of the operative speed would be nearly, or exactly, equal to the frequency of the free oscillation of the system, if displaced from natural state of rest and let go.

How many distinct synchronous speeds a system is capable of having depends upon the number of degrees of freedom. An absolutely free system, for instance,

placed upon an elastic sub-foundation, may have six independent synchronous speeds, or "critical" speeds, as they are sometimes called. A massive foundation resting upon rock is likewise often apt to be, in the larger sense, free in all six degrees, since it occasionally *does* vibrate and propagate the vibration to other buildings, etc. A system with one fixed point may have only three such synchronous speeds, while a system mounted to rotate about an axis can have only one such speed or "period," as it is often termed. If we could control these synchronous speeds, so as to make sure that none comes anywhere near the actual speed of operation of the machine, we would then have a fairly complete solution of our problem.

Vibration in a Body with One Degree of Freedom

In order to understand clearly the foregoing as well as the broad methods here proposed, let us consider the following experiment and the general consequences manifestly derived therefrom: Imagine a pendulum, as in Fig. 3-A, consisting of a platform P rigidly connected to the member Q by means of the side members N. The system is free to swing about the axis A in the plane of the figure. A small motor M fastened on the platform P operates a countershaft carrying an off-center weight W. The motor is fed through a suitable flexible connection and it is always possible to adjust the speed of the countershaft carrying the weight W so that the number of revolutions per minute of the former will be equal to the number of double oscillations per minute of the pendulum system, if the latter is slightly displaced from its vertical position of equilibrium and let go. The effect of this adjustment of speed will be the so-called "synchronism," and the extent of swing (amplitude) of the pendular system, in general very slight for arbitrary values of the rotative speed of the weight W, will now become violent, in fact, out of all proportion to the magnitude of the weight W itself.

This phenomenon of synchronism of cause and effect has been well studied. The amplitude at the exact condition of synchronism should theoretically be infinite, but of course in practice resistances of various kinds are always present, so that instead of *infinite* we have *large* amplitudes. The most curious fact is that in the vicinity of synchronous speed, both above and below, the amplitude drops down to a value almost insignificant, so that if the weight W is small the system appears to be practically at rest. Furthermore, any further increase of speed will not produce any effect, contrary to the current opinion of those not very well versed in the matter. For the sake of illustration let this synchronous speed be 100 r.p.m.

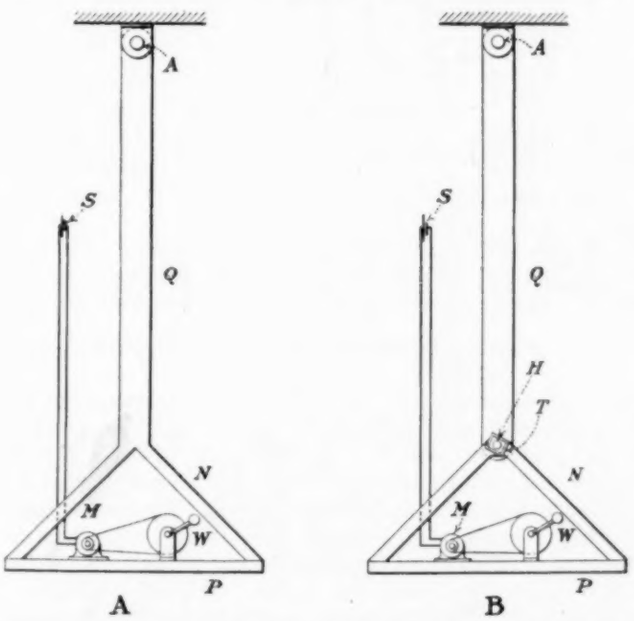


FIG. 3 A—SYSTEM WITH ONE DEGREE OF FREEDOM; B—SYSTEM WITH TWO DEGREES OF FREEDOM, ONE OF WHICH MAY BE SUPPRESSED

Vibration in a Body with Two Degrees of Freedom

As a modification of the experiment let us now provide another system, shown in Fig. 3-B, identical with the first except that the platform P is not solid with the member Q but is pinned thereto at H, the pin used being both frictionless and at the same time so arranged that it can be tightened up by means of the nut T, so as to lock the joint, thereby securing the exact effect of the rigid pendular system of Fig. 3-A. Providing the pin H, in the language of dynamics, is the *introduction of an additional degree of freedom*, thus securing a system with two degrees of freedom; while the tightening of the nut T amounts to *suppressing one of the degrees of freedom*, thus converting a two-degree into a one-degree system. In experimenting we shall first deal with the system of one degree of freedom, tightening the nut T and thus converting the pendulum into a system exactly similar to that discussed above, the synchronous speed being, say, 100 r.p.m. The pendulum will oscillate violently. We now loosen up the nut T, introducing an additional degree of freedom, with the apparently surprising result that the amplitude decreases practically to zero. If we reduce the speed considerably, say to 50 r.p.m., violent oscillations of the whole system will reappear, as will likewise be the case in speeding up the countershaft, say to 150 r.p.m. These figures are purely illustrative; whether they will actually correspond to facts will depend upon the characteristics of the system.

In other words, by introducing an additional degree of freedom we have accomplished this double result: (1) What was synchronous speed for a system with a single degree of freedom is no longer synchronous speed for the same system provided with an additional degree of freedom; (2) the new system has two frequencies of oscillation, at which it is sensitive to disturbing influences (such as centrifugal action of the weight W), one being below and the other above the value corresponding to that of the same system with the additional degree of freedom suppressed.

It should especially be observed that the oscillations were thus reduced practically to zero, not by steadying the system by something without it, but by some sort of an adjustment wholly within the vibrating system itself. Furthermore, what we did was to increase in a measure the flexibility of the system by breaking it in two; and although at first glance this might have increased the effects of the disturbing agency (rotation of off-center weight W), the actual effect was practically to bring the system to rest. It is still more important, however, to note the fact that we introduced the additional degree of freedom precisely in the sense of action of the disturbing agency, that is, in the sense of the plane of the figure and not at right angles thereto; or, say, in an up-and-down sense, as for instance by providing a coil spring instead of joint H.

This, then, will be taken as basis for our further discussion: In contemplating the design of a foundation we shall always separate those directions, or axes of instantaneous rotation, about which the system cannot, or at least is not likely to oscillate from those directions, or instantaneous axes, about which the system is more or less certain to vibrate. We next shall select a "steady" point from purely practical considerations, and

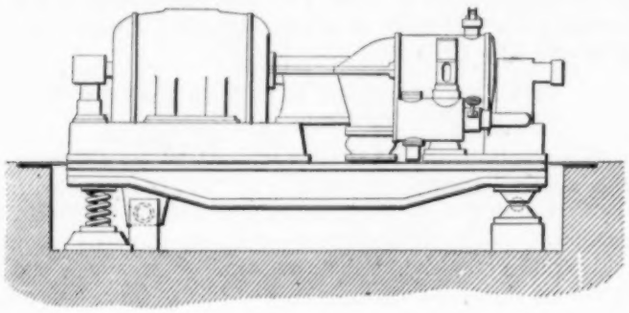


FIG. 4. APPLICATION OF THE AUTHOR'S DESIGN TO A TURBO-GENERATOR

finally devise such means of controlling the "free periods" of the system as will secure the desired degree of remoteness from synchronism under the actual operative speed. Such means of course will be springs, exceedingly heavy, and not in the least calculated to allow of any free wabbling of the system. They will also be adjustable so that the desired periods may be readily varied within wide limits; and in general structurally arranged to introduce as few changes as possible in the arrangement as a whole.

The author feels that to submit too many particulars as regards the detailed designs of such an arrangement would certainly defeat the purpose of this paper, which is merely to introduce the broad idea and not any one of the scores of individual designs which might readily suggest themselves to the engineer confronted with the problem of designing a foundation for a given machine. Considering, therefore, only one type of apparatus, a turbo-generator, shown in Fig. 4, we must start out with the selection of the steady point. We will naturally place it as near the steam main as possible (not to the exclusion, of course, of a suitable expansion joint), as under all conditions, should there be a choice of position, preference should be given to that point as far as possible from the center of gravity of the system, so that any static unbalance (whipping, etc.), would be made to act not as a force *upon*, but as a moment *about* that steady point. Such point should actually be made as steady as possible and no trouble should be spared in providing suitable piling or digging down to the solid ground and constructing suitable footings.

The next problem is to design a substructure adapted to receive the bedplate of the apparatus and made stiff enough so as to eliminate any "periods" of its own. This bedplate may be made of structural steel or of reinforced concrete, in which latter case the ends thereof may be made of cast iron. The substructure is supported upon the steady point either by a ball-and-socket arrangement, or is simply bolted at that point to the floor plate underneath by a bolt, which need not necessarily be very light but which must be arranged in a manner to secure the minimum area of actual contact. Remembering that in apparatus of this sort the tendency to oscillate about the axis x, referring again to Fig. 2, is always rather negligible, we have practically only two degrees of freedom and only two periods to adjust so as to have them well out of the limits of the operative speed. Hence the two sets of springs, one to take care of the period corresponding to oscillation in the vertical plane, the other to control motion in the horizontal plane. It should not be imagined, however, that these springs will necessarily be very light; they will always have considerable stiffness, but their function is that of being the only members that *can* yield and the whole situation is controlled by the proper choice of these yielding elements.

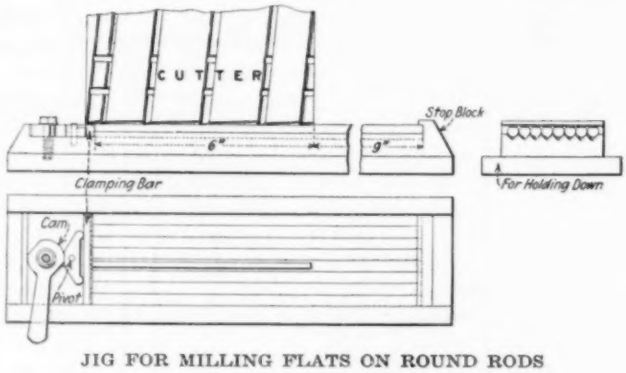
Cutting Flats on Wire Rods

By S. A. Inscoe,
Wolverhampton, England

The question opened by F. C. Hudson on page 1267, Vol. 52, of *American Machinist*, is one of many such to be constantly met with in production work. It is tantalizing in that while the operation is insignificant in itself and the whole cost of the job should be negligible, to carry it out in a workmanlike manner much scheming and sometimes expensive equipment must be used.

The punching method may be successful, although one would think that punching or shearing a flat on round work would not be conducive to accuracy, as the metal removed would leave a burr, and the pressure of the punch squeeze the wire somewhat out of round; also, the operation would be slow. It might be possible to make a die with a flat shaving cutter let into one side, and moved back by a cam actuated by the punch when the 6-in. mark was reached; but here again only one could be done at a time, and it would necessitate a press with a very long stroke.

An operation very similar to the one required may be seen in almost all shops engaged in the manufacture of gear box details for motor cars. The bars carrying the forks for moving over the sliding gears have either a flat, or a series of grooves or countersinks, along one



JIG FOR MILLING FLATS ON ROUND RODS

side. A sketch of the method used is shown herewith and is almost self-explanatory; being a jig base having a series of V-grooves to carry the work, which is placed under and against the stop block, and clamped by end-pressure with a cam-operated clamp. Two such jigs, having a number of grooves each, could be used on a vertical milling machine; one being loaded while the other is passing under the cutter. The only arbitrary condition is that the wires must all be of the same length so that they can be securely and accurately clamped in the jig.

Avoid Trigonometric Solutions Where Geometry Will Do

BY FRANCIS W. SHAW

Didsbury, Manchester, England

The problem contained in the accompanying diagram is one of many connected with triangles and circles, in solving which our old friend Euclid found little difficulty without calling to his aid those expedients of more modern geometricians—the angular functions. "Expedients," I have said; "hindrances" would oft be the better term—a term that would fit the case in point.

Ernest T. Goodchild, on page 32 of the present volume of *American Machinist*, in solving the problem of locating the center of the circle which shall pass through the points A, B and C and in determining its radius, has first of all set himself to find the angle A. That has involved the use of the well-known formula: D (diameter) $= a \div \sin A$. To determine A required in solving this equation, he has had to employ the formula $\cos A = (c^2 - b^2 - a^2) \div 2cb$ and to insure sufficient accuracy the angle has been determined to a decimal part of a minute.

Had A B been much closer to O as indicated by the thin lines in the illustration, the angle A would have had to be calculated even more exactly.

Now, a formula applicable to this problem (I do not purpose to show its derivation) is

$$R = \frac{abc}{4\sqrt{s\,(s-a)\,(s-b)\,(s-c)}}$$

where

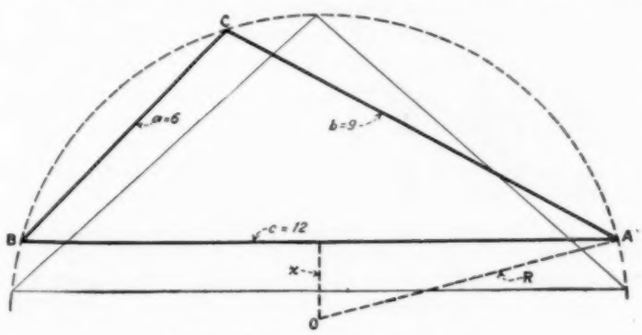
$$s = \frac{a+b+c}{2}$$

For a case involving simple numbers I should proceed first to express the sides of the triangle in the simplest form possible. In this case we might divide the sides by 6, getting: $a = 1$, $b = 1\frac{1}{2}$, $C = 2$. R will, of course, become $R \div 6$.

Thus:
$$\frac{R}{6} = \frac{1 \times 1\frac{1}{2} \times 2}{4\sqrt{2\frac{1}{4} \times 1\frac{1}{4} \times \frac{3}{4} \times \frac{1}{4}}} = \frac{3}{4\sqrt{\frac{135}{256}}}$$

whence
$$R = \frac{72}{\sqrt{135}} = \frac{72}{11.619} = 6.1968$$

x can now readily be determined from the small right-angle triangle. The square root of 135 appears in tables in most hand books.



FIND x AND R GEOMETRICALLY

Converting Micrometer Readings Into Metric Measure

BY CHESTER E. JOSSELYN

The following table facilitates the operation of converting micrometer readings into metric measure.

Example: A micrometer reading is 0.672 in., which shows six 0.1-in. divisions, two 0.025-in. divisions and twenty-two 0.001 divisions. Six 0.1-in. divisions = 15.24 mm.; two 0.025-in. divisions = 1.270 mm.; and eleven 0.001-in. divisions = 0.5588 mm. The total is 17.0688 mm. Proof: 672 ÷ 0.03937 — 17.0688 mm. (0.03937 = 1 mm.). When using a larger micrometer, add 25.40 mm. for each inch measured.

TABLE FOR CONVERTING MICROMETER READINGS INTO METRIC MEASURE

One-tenth-In. Divisions	Metric Equivalent in Millimeters	Twenty-five One-thousandth-In. Divisions	Metric Equivalent in Millimeters	One-thousandth-In. Divisions	Metric Equivalent in Millimeters
1	2.54	1	0.635	1	0.0254
2	5.08	2	1.270	2	0.0508
3	7.62	3	1.905	3	0.0762
4	10.16			4	0.1016
5	12.70			5	0.1270
6	15.24			6	0.1524
7	17.78			7	0.1778
8	20.32			8	0.2032
9	22.86			9	0.2286
10	25.40			10	0.2540
				11	0.2794
				12	0.3048
				13	0.3302
				14	0.3556
				15	0.3810
				16	0.4064
				17	0.4318
				18	0.4572
				19	0.4826
				20	0.5080
				21	0.5334
				22	0.5588
				23	0.5842
				24	0.6095

EDITORIALS

Are You Sure of Your Cost Figures?

COST accounting is a modern business tool that is too little understood and too little used. Business conditions in the last five years have been such that this attitude of manufacturers toward the matter of accurate costs is not to be wondered at. When a man is unable to accept all the orders offered to him and prices are high and rising still higher, it is only natural that he is more interested in getting the goods out than in keeping close track of the cost of every operation.

But with a falling market and no orders in sight the situation is different. When the present readjustment is complete and the manufacturers of the country go after business on a competitive basis, the prizes are very apt to fall to the man who knows what it costs him to manufacture an article and who can figure his bids accordingly. The man who overbids through overestimating his costs naturally gets few orders, while the fellow who underbids soon reaches the bankruptcy court.

Now, if ever, is the time to push any practical means of bringing home to the man who needs it most, the value of determining his costs accurately. What appears to us to be an eminently practical plan is the organization of the Industrial Cost Association which was announced in our news pages recently.

The objects of the new association are praiseworthy. As stated by the founders they are:

(a) To stimulate the interest of all manufacturers in accurately determined costs.

(b) To standardize cost and accounting nomenclature; to establish governing principles; and to simplify cost accounting.

(c) To educate the members in the use and advantages of graphic charts and other modern methods of cost analysis and control.

(d) To assist members of the association who are identified with cost committees of trade organizations in formulating uniform cost methods, and to recommend to members the adoption of such uniform methods.

(e) To facilitate the elimination of unintelligent competition by encouraging the interchange of cost data among members engaged in similar lines of industry.

(f) To provide a forum for the discussion of cost problems and practices through general and local meetings; and to gather and disseminate news of interest to members.

(g) To establish a library of cost literature, and to maintain a bureau of information through which members may be assisted in the solution of their individual cost problems.

(h) To co-ordinate the efforts of members to the end that cost of production may be considered in its proper relation to the complex problem of industrial management.

A valuable use for the accurate knowledge made available by an accurate cost system was indicated in the leading article in last week's issue where the perils of over-expansion in boom periods were brought out most convincingly. While a thorough knowledge of his manufacturing costs might not protect a man from the effects of his own enthusiasm, it would certainly make him think twice before rushing into a wild campaign of expansion. And if the second thought took account of the inevitable slowing down that follows every period of prosperity it would have been a thought worth thinking.

There are many other situations where the services of such an association would be of real value. Among them is that existing among the various local cost associations and trade associations with standardized cost accounting methods of their own. It is not to be wondered at that no two of the systems evolved are at all alike. Most of them have their good points but to get the maximum benefit from their efforts they should be co-ordinated and simplified so that a uniform practice may be developed. Steps have already been taken in this direction.

The present membership of the new association includes some of the best-known and best-managed companies in this country. We hope their lead will be followed by many more.

The Increasing Safety in Aviation

A SIGNIFICANT and interesting sidelight on the development of aviation may be seen in the Army air race which took place on Thanksgiving Day on Long Island. There were over forty entrants and the fastest speed was about 178 miles an hour in a 160-mile race. Nearly all finished and there was no serious accident of any kind.

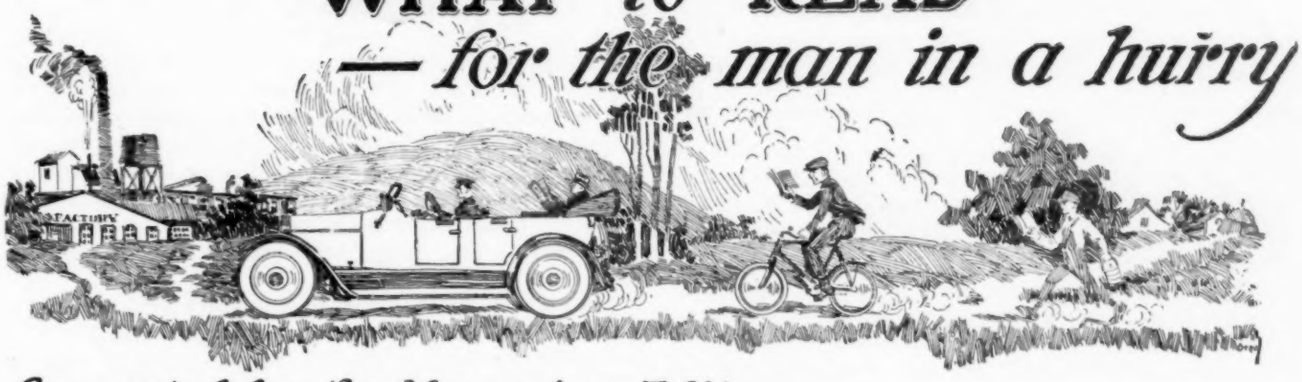
An automobile race was held in Los Angeles on the same day. The speed was less than half that of the air race and there were fewer entrants. Yet there were three fatalities and a fourth is probable.

This does not argue against automobiles or automobile races. It simply means that we must revise some of our notions as to the dangers of aviation. There is still much to be done and flying still has its dangers.

It seems likely that the development problem must be solved by the Army and the Navy. Administration policies in aviation matters have resulted in the practical starvation of private enterprise and one big company after another has shut up shop or filed a petition in bankruptcy.

The recently issued report of the Director of the Air Service indicates that the Army, at least, is fully alive to its responsibilities. The Director says, "This office has allotted to the Engineering Division for expenditure in the design, development and test of aviation material, every dollar that could be spared from other activities. It was deemed best that the Air Service should worry along with what equipment it had in order that the Engineering Division might be permitted to purchase for its own purposes the few airplanes that the appropriations of the past year would permit to be procured." The Director is to be commended for his stand and it is to be hoped that he will be encouraged in his work by increased appropriations for this very necessary development work.

WHAT to READ —for the man in a hurry



Suggested by the Managing Editor

IN THIS issue we announce the change of one more *American Machinist* editor from journalistic work to another field. Ethan Viall, whose likeness appears below, ended ten years of service on the staff on the fifteenth of this month. He leaves to take over the management of a Middle-Western manufacturing plant in which he has been financially interested and the growth of which demands his entire time. His new work will enable him to spend a greater portion of his time out-of-doors and thus to build up his health which has suffered from the confining nature of the positions which he has recently held.

What to read was not a difficult matter to decide two hundred years ago when books were few and magazines unheard of. It is far different now when so much reading matter is offered to pass the time pleasantly or profitably as the reader chooses. We are doing our utmost to make the "American Machinist" not only profitable but indispensable as a clearing house of ideas and news of the machinery world. This page is the editors' advertisement of their section of the paper. It gives the high spots

After two years as associate editor in the old New York office, Mr. Viall went to Cincinnati as western editor. He was recalled to New York in 1917 to serve as managing editor until he was made editor just a year ago. His successful fight against the compulsory adoption in this country of the metric system of measurement was a feature of the editorial policy of the *American Machinist* for 1920. Mr. Viall's cheery presence will be greatly missed by the members of his staff. It is no small honor to earn the appellation "the whitest man I ever worked with."

Mr. Viall's place is taken by K. H. Condit, the former managing editor, whose job descends to his former assistant, L. C. Morrow. The new line-up appears at the top of the Contents page.

This unpleasant duty disposed of—farewells are never pleasant—we turn to the contents of the current issue. The leading article is the first of a short series describing the methods in use in the Hall-Scott motor shop on the Pacific coast. On page 1122 is the beginning of a brief technical discussion of the theory of transmitting power by waves in a column of liquid. The best-known application of the theory is the "C. C." gear used in the war to fire airplane guns shooting through the propeller path. A British company has undertaken to apply the same principle to rock drills, riveting hammers and similar devices.

The fifth part of "Seven Centuries of Brass Making" takes up the production of sheets and the extrusion of rods and wire in a modern manufacturing plant. It starts on page 1133.

The annual meeting of the American Society of Mechanical Engineers is in progress as this is written. The papers presented have in many cases been of unusual interest. On page 1145 we have one by N. W. Akimoff, presenting a theory for the design of machinery foundations. Mr. Akimoff's work in the field of machine balancing is well known and serves as a basis for this particular theory. Our account of the events of the meeting is on page 1156. The first meeting of the new Machine Shop Section was well attended and brought out two very interesting papers and a lantern-slide talk that was well received. We are running the first half of one of these papers starting on page 1152. It is by W. H. Chapman of the Norton Co. and comprises a study of the laws involved in cylindrical grinding. The other paper, by Major Buckingham of the Pratt & Whitney Co., is based on two years of investigation of the side-cutting action of thread-milling hobs, and will be published next week.

Cylindrical Grinding in 1920*

By W. H. CHAPMAN

This paper comprises a study of the laws involved in cylindrical grinding and an analysis of grinding action (1) for draw-in cuts and (2) for traversed cuts. Grinding efficiency is usually considered as (production) ÷ (wheel wear). Accordingly formulas are derived for wheel wear in terms of grain size of wheel, work speed, wheel speed, feed, etc. By calculating values for wheel wear for different conditions and comparing them with production figures calculated under the same conditions, a proper selection of wheels may be made. The paper concludes with a discussion of production costs and with a series of practical conclusions, one of the most important of which is that increase of traverse speed increases production without increase of wheel-wearing action.

INDUSTRIAL engineers have long realized the value of the application of science to the operation of machine tools. One has but to consider the work of Taylor and others to appreciate this. As the grinding machine has come to be an important production machine only within a relatively short period, there has not been a large amount of accurate information available with regard to its operating features, more especially from the standpoint of obtaining the most economical grinding conditions. It is the purpose of this paper to report some recent developments along these lines.

Theoretical Considerations

In December, 1914, Professor George I. Alden presented a paper to the Society setting forth his theory of "Grain Depth of Cut." A formula was developed involving the velocities of the wheel and work surfaces, the grain size of the wheel (number of cutting particles per unit length of circumference) and sine functions of the angle formed by tangents to the work and wheel circles at their point of intersection. This work was a pioneer of its kind in this country. It clearly showed that the kinematic relations between the cutting grains and the work surface were of the greatest importance during cylindrical grinding operations, and that wheel wear and production rates would vary according to the mathematical laws involved.

In his book "Grinding Machinery," published in England, J. J. Guest develops expressions to indicate the mathematical relationships between the cutting grains and the work surface. He calculates what he terms "Normal Velocity of Material," "Controlling Factor," and "Maximum Output," and he finds that a change of work speed has an effect upon wheel wear far greater than a change in depth of cut. This agrees with Professor Alden's conclusions. Mr. Guest deduces a formula for Controlling Factor, in which the work speed enters as a squared function and depth of cut or feed enters as a first power.

*Presented at the annual meeting, New York, December, 1920, of the American Society of Mechanical Engineers, 29 West 39th Street, New York.

The operator must know how to select wheels of the proper abrasive, grain and grade for the piece to be ground. This he will determine by experimenting until he learns what to choose in any particular case.

The variables which must be controlled by the operator, once he has chosen his wheel and set up for the job, are:

(*a*) Wheel speed—usually constant r.p.m. with surface speed decreasing as wheel wears;

(*b*) Work speed—variable r.p.m. provided over a large range;

(*c*) Traverse speed—variable from about 3 to 36 ft. per min. in the latest machines;

(*d*) Depth of cut—controlled by graduated feed mechanism, graduated in units of 0.00025 in. on work diameter;

(*e*) Rate of feed—uniform in-feed for non-traversed work, in-feed at end of traverse zone for traversed work;

(*f*) Ratio of traverse per work revolution to width of wheel face.

We will assume the wheel speed to be constant, since a well-designed machine will be sufficiently powered to maintain its speeds, even under reasonably heavy cuts. Theoretically, the traverse per revolution should be sufficient to allow the wheel face to just cover the lead and not present the same work surface to the cutting face more than once per traverse. This condition can be brought about by computing the lead of the work for the various combinations of work and traverse speeds, or from inspection of the work itself while grinding is in process. In the following mathematical considerations the exact coverage of the lead by the wheel face is assumed.

The rate of feed should theoretically be one increment per revolution for non-traversed cuts and one increment per traverse for traversed cuts. A traverse is considered to be a single stroke between the traverse limits, and may therefore be either left to right or right to left. Where one traverse limit is at the driven end and the wheel cannot be allowed to overtravel the end of the work, a non-traversed cut should be taken down to very nearly the finished size, and then the traverse limit established so that the wheel will not strike the shoulder on the limit side of this cut, but will overtravel the opposite side of the cut for part of the wheel width. This practice saves the edge of the wheel on the side toward the work dog.

Having established our method of grinding, we are now prepared to study the scientific laws involved and their operation under these conditions.

Mathematical Analyses

In order to analyze the grinding action we must visualize just what occurs as the grains pass through the arc of contact with the revolving work piece. This may be done by imagining a cross-section through the wheel and work, and by studying action in the section plane, the entire wheel action being the integration of all section planes normal to the axes of rotation of the wheel and the work. We may also greatly magnify the size of the grains and the dimensions of the rotating

members, for the same mathematical relations obtain regardless of actual dimensional values. Therefore, in the accompanying diagrams the dimensions are not in proportion to those actually existing, but have been distorted for the purpose of exaggerating the conditions within the arc of contact. The depth of cut, size of chip, and size of grains are all greatly exaggerated. This, however, should not result in any confusion as to the proper illustration of the theoretical grinding action.

Analysis of Grinding Action for Draw-in (Non-Traversed) Cuts

We will first consider the case of draw-in cuts where the zone to be ground is of a length equal to the width of face of the wheel. Theoretically, the feed increment should occur once per work revolution to maintain uniform action. The work revolves in a direction opposite to that of the wheel.

Considering the two intersecting circles, the wheel and work peripheries, the wheel travels at a much

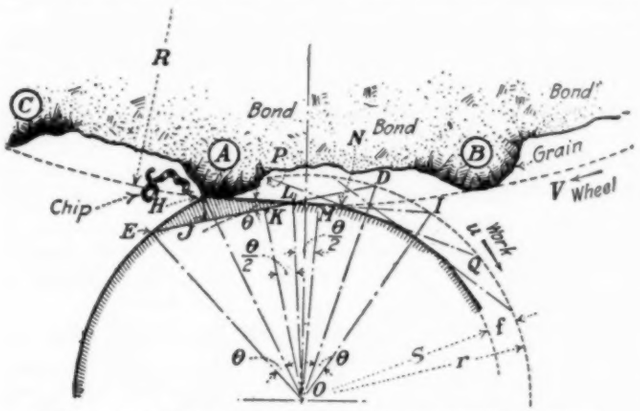


FIG. 1. DIAGRAM ILLUSTRATING CUTTING ACTION

higher rate than the work. A point on the wheel periphery describes a path within the point of intersection. It is the form of this path traced upon the work itself in which we are interested, for the shape of the chip removed by a cutting point on the wheel is an area bounded by the work periphery and by two successive grain paths. (The third dimension, width of chip, is unimportant in so far as cutting action is concerned.) An analysis of the motion of the wheel relative to the work (consider the work not moving) shows that the wheel is rolling around the work surface but revolving at a higher rate than that required to accomplish pure rolling. The grain path, therefore, is in the nature of an epicycloid, but extended because of the slip between work and wheel surfaces.

The criterion of wheel wear is the maximum depth of the chip removed, this depth being measured at right angles to the path of the cutting grain. We will therefore develop an expression for this depth, the variables of which are controlling factors of grinding action, as follows:

N = r.p.m. of wheel;
V = surface speed of wheel;
u = work speed in ft. per min.;
R = wheel radius in inches;
r = work radius in inches;
f = depth of cut, inches on work radius;
μ = interval between grains in fractions of an inch.

Other symbols used are:
S = feed circle = $r - f$, inches;
G = maximum depth of chip, inches.

The value G corresponds to Professor Alden's Grain Depth of Cut. The grain interval μ is the quotient of the number of cutting particles on the wheel periphery and the circumference of the wheel in inches (considering the wheel width equivalent to a single grain). This value may be determined for various wheels by actual count and measurement. It varies with both grain size and grade of wheel.

Refer to Fig. 1 in which greatly enlarged section of wheel and work is shown. The grain paths across the work are indicated and a shaded area indicates the shape of a single chip. The grain paths are shown as straight lines tangent to the feed circle. Actually these paths are not straight lines but are the epicycloidal form of curve above mentioned. However, within the limits of probable dimensions which are actually involved in any cylindrical grinding operation, a graphical layout of the grain paths on a large scale (say $\frac{1}{4}$ in. = 0.0010 in.) will show that these curves are so nearly straight lines that the error is negligible. The mathematical relations are greatly simplified by this assumption. By actual trial it was found that there was seldom over 2 per cent difference in the values of maximum chip depth obtained by the use of the *actual* and the *assumed* forms of grain path.

Within the limits of reasonable working stresses, the wear of any cutting tool is roughly proportional to the total work done. The grain cuts until it is so dulled that impact tears it from its setting of bonding material or causes fracture, exposing fresh cutting points. The frequency with which the grain is applied, the average grain depth of cut as indicated by the chip dimensions, and the kinetic energy of the grain due to its mass and velocity, are the three factors which are to be considered as determining the wheel-wearing action. Frequency of application depends upon the revolutions per minute of the wheel. Work done is measured by the dimensions of the chip removed by each grain and the total number of chips removed. Kinetic energy is proportional to the mass and square of the velocity of the cutting particles.

Frequency of application of the grain = $N = \frac{12V}{2\pi R}$, and volume of wheel wear = $\frac{12V}{2\pi R} \times 2\pi R$. Therefore wheel wear is directly proportional to $12V$; or dropping the constant, is directly proportional to V.

Wheel-wearing action is also proportional to grain depth of cut G, for it is this factor alone which controls the actual depth to which the grain penetrates, and therefore the rate at which the bond is worn away by mechanical rubbing against the work surface. In making this statement it is assumed that the grain and grade of the wheel are such that the true grinding action of the wheel is taking place, that is, that the grain does not wear appreciably but dulls until the cutting becomes a rubbing and the grain is torn out from the setting of bonding material, which has been weakened by the wearing away due to contact with the work surface.

In Fig. 1 path QNP is generated by grain C; grain A follows at the arc distance μ and generates path ILH and is removing the chip of area PNH. The ground surface is made up of the successive paths and is not truly cylindrical, as small projections are left

of the form *KLM*. These are immeasurably small. The grain *B* will generate *DLE* and cut chip *EHL*. The depth of this chip normal to the path *DLE* is *JH*, which we designate as *G*, grain depth of cut.

Formula for Determining Depth of Cut. To find an expression for *G* in terms of the variables already enumerated, we have:

HLI is tangent to circle of radius *S at M*; $(S = r - f)$

EJL is tangent to circle of radius *S* at *K*

HLI and *ELD* intersect and form angle θ

DI (arc) is the distance through which the work moves while the wheel moves through the distance μ between grains.

$$EH = \frac{\mu u}{V}$$

Other necessary nomenclature has been already given.

Drop perpendiculars to *ELD* and *HLI* from *K* and *M*. Then

$$KO = MO = S = r - f$$

$$Angle\ KOM = \theta$$

$$\text{Angle } KOL = LOM = \frac{\theta}{2}$$

$$G = JH = HL \sin \theta \qquad (1)$$

Angle θ is very small and where expressed in radians is very nearly equal to its sine. Therefore

$$G = JH = HL \times \theta$$

But

$$\theta \text{ (in radians)} \times r = \text{arc } EH = \mu \frac{u}{V}$$

or

$$\theta = \frac{\mu u}{Vr} \qquad (2)$$

Therefrom, from (1)

$$G = JH = HL \frac{\mu u}{Vr} \qquad (3)$$

In triangle *OHM*, $HO = r$ and $MO = S = r - f$, therefore

$$r^2 - (r - f)^2 = \overline{HM}^2$$

and

$$f(2r - f) = \overline{HM}^2$$

But $(2r - f) = 2r$ (very nearly), as f is rarely over one or two thousandths of an inch and is very small compared to $2r$. Therefore,

$$2rf = \overline{HM}^2 \quad \text{and} \quad HM = \sqrt{2rf} \qquad (4)$$

LM is very nearly equal to arc of radius $(r - f)$ of angle $\frac{\theta}{2}$. Assuming it to be equal, $LM = \frac{\theta}{2}(r - f)$.

As before, f may be neglected, due to its extremely small effect upon r. Then, from (2),

$$LM = \frac{\theta}{2} r = \frac{\mu u}{2V}$$

Since $HL = HM - LM$, we have from (4),

$$HL = \sqrt{2rf} - \frac{\mu u}{2V}$$

and from (3),

$$G = JH = \left(\sqrt{2rf} - \frac{\mu u}{2V}\right)\frac{\mu u}{Vr} \text{ (very nearly)} \qquad (5)$$

The above represents the grain depth of cut very closely, and is expressed in the terms which were previously chosen.

Formula (5) may be rewritten as

$$G = \frac{\mu u}{V}\sqrt{\frac{2f}{r} - \frac{\mu^2 u^2}{2V^2 r}}$$

By inspection, bearing in mind that μ is always small, say 0.05 in., u is seldom over 200, f is seldom over 0.001 in. and V usually about 6,000, and r, say 1 in. to 4 in., we are justified in further reducing the expression mathematically by dropping the term $\frac{\mu^2 u^2}{2V^2 r}$ as being insignificant compared with the other two terms. Therefore

$$G = \frac{\mu u}{V}\sqrt{\frac{2f}{r}} \text{ (approximately)} \qquad (6)$$

This enables us to deduce approximate statements as follows: Grain depth of cut varies directly with grain interval, work speed, and square root of radial feed; inversely with wheel speed, and square root of work radius.

The relationship between work speed and feed is as determined by Mr. Guest in his Controlling Factor. The value of *G* also tallies with Professor Alden's results within the usual speed and dimensional limits found in cylindrical grinding.

Wheel-Wearing Action. The kinetic energy of the cutting particles increases with the square of the velocity.[1] For a certain depth of cut the resistance of the work to the grain is very nearly proportional to this depth, as the cuts are very small, even when compared to the total size of the grain. Theoretically, for some low velocity the kinetic energy of the grain should just equal the energy required to remove the chip (the feed would be reduced to maintain constant grain depth of cut under reduced wheel-velocity conditions) and wheel wear would be caused without any chip being removed up to this point. Actually the bond strength is always sufficient to prevent this condition. Our assumption is then clear:

Wheel wear varies inversely with the *surplus* kinetic energy of cutting particles and is inversely proportional to *effective* wheel surface velocities (wheel speed minus work speed).

We are now prepared to combine our factors.

a Wheel wear is proportional to the wheel speed, or to V.

b Wheel wear is proportional to the grain depth of cut, as expressed in Formula (6).

c Wheel wear is inversely proportional to surplus kinetic energy of the cutting particles, or proportional to $1/(V - u)^2$. The term u is usually negligible as compared with V and it may therefore be assumed that $1/V^2 = 1/(V - u)^2$.

From these relations, *a*, *b* and *c*, an index of wheel-wearing action (WW_I) due to grinding (where the wheel face is free-cutting) may be expressed as follows:

$$WW_I = V\frac{\mu u}{V}\sqrt{\frac{2f}{r}} \times \frac{1}{V^2}$$

$$= \frac{\mu u}{V^2}\sqrt{\frac{2f}{r}} \qquad (7)$$

Laws of Grinding for Draw-in Cuts

From this expression we may derive the following laws of cylindrical grinding, operative *within the usual limits of speeds and dimensions.* For straight-in (draw-in) cuts a free-cutting wheel will wear according to the effect of wheel-wearing action as outlined below:

a Wheel-wearing action increases directly as:

1. Grain interval (grain size—inversely as grade)
2. Work speed (surface)
3. Square root of diametral cut (feed).

[1] See "Selection of Grinding Wheels for the Foundry," *Grits and Grinds*, January, 1915, the Norton Co., Worcester, Mass.

b Wheel-wearing action increases directly as the following are decreased:

1. Square of wheel speed (surface)
2. Square root of work radius.

A soft wheel is more susceptible to wheel-wearing action than a hard wheel and will more nearly follow the theoretical conditions. It is therefore more free-cutting and will cut more nearly the full chip than a hard wheel. There is consequently a gain in production as wheels of softer grades are used, all other conditions remaining constant, up to the point where the chips are geometrically perfect for a given condition of speeds and dimensions. It is clear from this standpoint that the softest possible wheel should be used. High wheel speeds up to the safe limit are of course necessary if the soft wheels are to perform in a satisfactory manner.

To show the practical application of Formula (7) for wheel-wearing action (Index of Wheel Wear), derived above, Table I is given.

In column 1 of the table are the work speeds provided on a recent grinding machine, given in order so that actual values can be experimentally obtained to check with the theoretical.

In the succeeding columns are two series of values as follows:

(1) Following the term "Production" are *approximate* values for cubic inches of metal removed per minute for a wheel 1 in. wide. These were calculated by the formula, Production = nominal work diameter $\times$ π $\times$ r.p.m. $\times$ depth of cut (assumed to be 0.0005 in.), which gives values slightly less than the true values.

(2) Following the terms "Wheel Wear" are values of the *actual* wheel wear obtained by multiplying the Index of Wheel Wear, calculated by Formula (7), by a constant derived by experiment. This constant is for convenience expressed in the form $1{,}800 \times 10^{4}$

Sample Calculation. In Formula (7) assume:

u = 53 r.p.m. = 13.9 ft. per min.
r = $\frac{1}{2}$ in. (work diameter 1 in.)
f = 0.0005 in.
V = 6,000
μ = 0.05
R = 9.0 in. (wheel radius).

Substituting,

$$WW_I = \frac{0.05 \times 13.9}{36{,}000{,}000}\sqrt{\frac{0.001}{0.5}}$$

$$= 0.0000000196 \times 0.047 = 9{,}212 \times 10^{-12}$$

Multiplying by constant $1{,}800 \times 10^{4}$ (see Par. 31),

WW_I = 0.0166 cu.in. per minute for wheel 1 in. wide.

The corresponding "Production" in Table I is, 0.0835 cu.in.

It will be seen that the wheel-wear values increase rapidly as work speed increases. The value 0.0166 for work of 1 in. diameter at 53 r.p.m. becomes 0.1040 for work of 4 in. diameter at 167 r.p.m. The same wheel cannot be properly used for both cases, as one sufficiently soft to cut freely in the first case would wear so fast as to be nearly useless in the second case. However, where wheel-wear values are nearly the same we may expect the same wheel to act properly. For instance, a wheel suitable for 1-in. work at 138 r.p.m. wears at the rate of 0.0433 cu.in. per min.; and one suitable for 4-in. work at 72.5 r.p.m. wears at the rate of 0.0450 cu.in. per min. In all probability one wheel would serve for both.

Selection of Wheels for Draw-in Cuts

From Table I, and by experimental tests with various wheels, certain ranges of wheel-wear values may be found which correspond to definite grades of wheels of suitable grain size and abrasive for the material to be ground. Once this is done, the selection of proper wheels is no longer a question of guesswork, as wheel-wear indices may be computed for any set of conditions and the proper wheel selected. The question of the variation in wheels has been reduced to a point where it no longer can be a very large factor, and we may always change our speeds or feeds to correct the action in the proper direction if we understand the laws which have been previously pointed out. As an example of the possibilities of wheel selection, it has been found that for a certain machine the following wheels (Norton system of grade) are suitable for straight-in cuts on mild steel:

TABLE I. COMPARISON BETWEEN WHEEL WEAR AND QUANTITY OF METAL REMOVED AT DIFFERENT WORK SPEEDS

Work Speed in R.P.M.		Work Diameters 1 in.	2 in.	3 in.	4in.
53	Production	0.0835	0.1670	0.2500	0.3340
	Wheel wear	0.0161	0.0236	0.0290	0.0334
72.5	Production	0.1140	0.2280	0.3420	0.4560
	Wheel wear	0.0226	0.0319	0.0390	0.0450
87	Production	0.1370	0.2740	0.4110	0.5480
	Wheel wear	0.0273	0.0387	0.0475	0.0546
101	Production	0.1586	0.3172	0.4758	0.6344
	Wheel wear	0.0316	0.0448	0.0540	0.0635
138	Production	0.2160	0.4320	0.6480	0.8640
	Wheel wear	0.0433	0.0612	0.0645	0.0865
167	Production	0.2620	0.5240	0.7860	1.0480
	Wheel wear	0.0522	0.0740	0.0910	0.1040

Wheel diameter 1° in.; surface speed, 6,000 ft. per min.; diametral feed per work revolution (automatic feed), 0.001 in.; grain of wheel, 6,646 Alundum; material, mild machinery steel.

Wheel Designation		Wheel-Wear Values, Table 1
36 or 46 J	for values from	0.0150 to 0.0250
36 or 46 K	for values from	0.0250 to 0.0350
36 or 46 L	for values from	0.0350 to 0.0450
36 or 46 M	for values of	0.0450 and higher

Use no wheels harder than M. For hard materials use a grade softer and No. 60 grain. These values are for straight-in cuts only.

Influence of Feed. As an example of the effect of doubling the feed, let us assume the conditions as above, except that the feed is increased to 0.001 in. (on radius).

$$WW_I = \frac{\mu u}{V^2}\sqrt{\frac{2f}{r}} = \frac{0.05 \times 13.9}{36{,}000{,}000}\sqrt{\frac{0.002}{0.5}}$$

$$= 1{,}240 \times 10^{-12}$$

Wheel wear = $1{,}800 \times 10^{4} \times 1{,}240 \times 10^{-12}$ = 0.0224 cu.in. per min. per inch of wheel face. Production is approximately doubled and

$$\text{Wheel-wear increase} = \frac{0.0224 - 0.0166}{0.0166} \times 100 = 35 \text{ per cent.}$$

This indicates how advantageously an increase of feed operates to obtain increased production (up to the limit of grain penetration). If we had doubled work speed we would simply have doubled both production and wheel wear.

(To Be Continued in Next Week's Issue)

Forty-First Annual Meeting of the American Society of Mechanical Engineers

THE forty-first annual meeting of the American Society of Mechanical Engineers got under way Tuesday morning, Dec. 7, with the opening of headquarters and registration bureau in the Engineering Societies Building, New York. Following the registration there was a meeting of the council.

The afternoons of Tuesday, Wednesday and Thursday were allotted to simultaneous sessions for consideration of two or three subjects each on the general topics, Fuel, Forest Products, Machine Shop Management, Design, Railroads, Research, Transportation, Power and Textiles.

There were two evening meetings, one devoted to the presidential address and reception and the other to an oration on "John Brashear as Scientist and Humanitarian," in memory of the late Dr. John A. Brashear, past-president A. S. M. E., by Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching.

Wednesday and Thursday mornings were given over to a business meeting and a session on transportation. At the business meeting Calvin W. Rice, secretary, commented upon the reports of standing and special committees, including those on a Code of Ethics, Power Test Codes, Weights and Measures, Education and Training, Feedwater Heater Standardization, Standard Tonnage Basis for Refrigeration, Fluid Meters and Bearing Metals. The following membership for the 1921 Nomination Committee was approved, this committee having been elected by the local section delegates: Elmer Smith, Boston, Mass. (alternate J. A. Hall, Providence, R. I.), G. K. Parsons, New York, N. Y. (alternate W. Herman Greul, New York, N. Y.), W. W. Varney, Baltimore, Md., B. S. Hughes, Buffalo, N. Y., W. M. White, Milwaukee, Wis. (alternate J. D. Cunningham, Chicago, Ill.), F. E. Bausch, St. Louis, Mo. (alternate D. E. Foster, Tulsa, Okla.), and E. O. Eastwood, Seattle, Wash. (alternate H. L. Doolittle, Los Angeles, Cal.). The student prize was awarded to Howard G. Allen, of Cornell University, for his paper, "Wire Stitching Through Paper."

By the amount of discussion regarding the code of ethics it was made evident that the code in its present form is not acceptable to a great many of the members, the faults found being chiefly with its wording, not with the spirit. A motion was passed to refer it back to the committee for further consideration.

Presidential Address and Reception

The address of President Miller was concerned chiefly with human relations in industry. He quoted in the beginning of his paper from Herbert Hoover's address as president of the Federated American Engineering Societies, the paragraph in which he said, "The engineers should be able to take an objective and detached point of view. They do not belong to the associations of either employers, or of labor, of farmers, of merchants, or bankers. Their calling in life is to offer expert service in constructive solutions of problems, to the individuals in any of these groupings. There is a wider vision of this expert service in giving the group service of engineers to group problems." The ideas expressed and suggested were developed by Mr. Miller. He explained that "the engineer must increase the effectiveness of labor by the application of brains and management of men as well as of materials." Speaking of employer and employee he said, "The improvement of the human race that is always going on takes many different directions and goes forward in many fields. The engineer shares, with his fellow beings, the results of the efforts of others and his own peculiar contribution to the cause of human progress must always continue to be an increasing power to control the forces and modify the materials of Nature for the benefit of mankind. A very important part of this work is what we term the problems of industrial relations; which, it is certain can never be satisfactorily solved except by the methods of the engineer and it is equally certain that it can never be settled until settled right; that is to say, not until all concerned—the employee, the employer, and the public—are convinced that substantial justice has been secured and is being maintained.

"Of course, there are and always have been employers who have been fair toward their employees; have been real leaders of men, able to arouse and maintain enthusiastic co-operation. Notable successes have been founded mainly upon this human ability or quality. In too many cases, however, the most profound thought that seems to have been applied to an industrial problem has led to the conclusion that industrial management consists in hiring as cheaply as possible and driving as hard as possible.

"The day for that sort of thing is passing and industry generally is beginning to be conducted upon a much higher plane of intelligence. It is being recognized that there is a science of industrial management. Engineers have, so far, developed and formulated it, must go on with it, and conduct the country's industries in accordance with it, recognizing that the old order has passed away. Management of an industrial group is not a matter of brute force, but of intelligent skill, fairly and sympathetically applied with a view to getting the best possible results, not only for the employer, but for the workers and for the public as well.

"If research is important in physics and in chemistry it is at least equally important in the domain of industrial science and when fundamental facts or laws have been made known by such research we must face them; not to do so may mean disaster.

"In general, the engineer bases his opinion and his acts upon definitely ascertained and carefully studied facts. We must do the same in our industrial management problems, and when we do, most of our industrial difficulties disappear."

Mr. Miller also said: "We are hearing constantly more about service as constituting the only just claim to rewards. Certainly the engineer need not fear comparison with others on that score. Yet there are those, who, with the best intentions, I am sure, charge a large share of our industrial and social difficulties to features of modern industry that have been created and are maintained by the work of the engineer.

"Especially do they charge that, doing things by machinery instead of by hand, and the multiplication of large manufacturing establishments in which the work is minutely divided, have had a bad effect—have, indeed made men and women slaves of the machines.

"I think that we may claim that there is a misapprehension about this and that machinery and large industrial establishments do not, nor can they, by themselves, enslave or oppress human beings.

"It is easily demonstrated by reason and by human experience that division of labor, machinery for increasing man's productive capacity and the use of capital in production all tend, by themselves considered, to help the worker—to release him from burdensome tasks and from the necessity of working too hard, or too many hours per day for too little money."

Conferring of Honorary Memberships

After the presidential address honorary memberships were conferred upon Lord William Weir, Glasgow, Scotland; Hon. Sir Charles Algernon Parsons, London, England; Commandatore Pio Perrone, Genoa, Italy; Rear Admiral R. S. Griffin, U. S. N.; Captain Robert W. Hunt, Chicago, Ill.; and Dr. Samuel M. Vauclain, Philadelphia, Pa.

President-elect Edwin S. Carman was introduced to the society by President Miller. In acknowledging the introduction Mr. Carman expressed his great appreciation of the high honor paid him. He also said that it was time for the engineer, who has been content to deal with purely professional matters, to undertake the solution of the greater problems of industrial relations, and to deal with them as he has with other problems by getting at the truth.

A reception was tendered to the president, president-elect, ladies, members, and guests by the society. The reception was followed by dancing.

Among the many important papers read before the society were the following, of particular interest to the machinery industry: "Side Cutting of Thread-Milling Hobs," by Earle Buckingham; "Cylindrical Grinding in 1920," by W. H. Chapman; "Mechanical Engraving and Die Sinking," by J. F. Keller; "Foundations for Machinery," by N. W. Akimoff; "Rational Design of Hoisting Drums," by E. O. Walters; "Design of Flywheels for Reciprocating Machinery Connected to Synchronous Generators or Motors," by R. E. Doherty and R. F. Franklin; and "The Armor Plate and Gun-Forging Plant of the U. S. Navy Department of South Charleston, W. Va.," by Roger M. Freeman.

Buyers with Vision—or Graft

By John R. Godfrey

"There's a great difference in business concerns as well as in people," remarked an experienced machine-tool sales engineer, as he settled down for an all-night run on the Pennsylvania Limited. "But I've almost always found that the firm which was right mechanically, finally won out. It may have a hard fight to get capital at first, but it gets there.

"Now there's the Blank Automobile Co. as an example. Lots of people laughed at it and knew it couldn't succeed. But it had real mechanics, with visions of the future and nerve enough to bank on it.

"I remember a case some years ago that opened my eyes. We'd designed a new machine for mass production and this company bought the first three we built. They were fine—when they ran. They'd turn out pieces in almost unbelievable time, and the next thing you knew, something would break.

"I'd been out there and watched them work in great shape and when I came back from lunch, all three were torn apart to fix some little thing that had let go. And I was sure discouraged. I went home expecting to get a call down any minute.

"Hadn't been home but a few days when I got a wire to come out again. I had visions of an exasperated shop superintendent who wanted to get a lot of 'peeve' out of his system. So I started prepared to be the goat, and take my medicine like a little man, though it meant several thousand dollars and loss of prestige to my firm.

"I wasn't feeling very cheery when I blew in the next morning. And I wasn't over-anxious to open the exercises. But he didn't seem inclined to, and as something had to be said, it was up to me to start the ball rolling.

" 'How are the machines going?'—knowing the answer before he spoke it.

" 'They aint—that's the trouble,' he said.

" 'I'm mighty sorry to hear that, Mr. Blank; hadn't you better send them back and let us get the bugs out of them? They seem to have a few still.'

" 'Oh, they've got bugs all right, but I'm not going to send them back. You can work the bugs out here. They're a damn nuisance so far, but you've got a big idea in that machine and we want the benefit of it first. I sent for you to talk over an order for a lot of fifty more to suit some of our other work. We'll help you get the bugs out and we want the saving made possible by those machines before anyone else.'

"Was I relieved? And happy? I'll say I was, and you can bet we tore our shirts to exterminate those bugs in the shortest possible time.

"But how many firms would have the vision, the patience and the nerve to do such a thing? For it meant thousands of dollars. Most shops would have thrown them out long before. But by nursing them along, the Blank Co. had about two years' start on the methods which they could develop with this machine."

A Different Story

"Some different from a motor outfit I know," chimed in another traveler. "You first go and see the super and get turned down, cold. Then you invite him down town to dinner that night. After dinner you propose cards or pool, preferably pool.

"You let him beat you of course. Any greenhorn would know enough for that after he saw the man. But the real fine work is in the side plays.

"First you make a little bet on the game—which of course he wins. Then you get real sporty and bet on plays, always managing to lose. If you see his ball within a reasonably easy shot of the pocket, you get excited and bet him a fifty that he can't make it. That gets his sporting blood up and he wins—and pockets the fifty. Two or three such bets put him in good humor and when you drop around next morning there is a long chance you get an order.

"I don't need to tell you that neither the product nor the equipment is up to standard. And you probably won't be surprised to know that this particular plant is sailing close to the wind, with breakers ahead.

"You're right about the necessity of having the mechanical end of a concern right. And that means having it know what real, old-fashioned honesty is when they see it. Some of 'em don't."

Improved Type of Optical Projection Apparatus Designed and Built by the Bureau of Standards*

BY LOUIS A. FISCHER
Chief, Division of Weights & Measures, Department of Commerce, U. S. Bureau of Standards

The extensive use of the projection lantern in the inspection of screw threads has lead the Bureau to devote considerable attention to the improvement and adaptation of this apparatus.

During the war a projection outfit similar to that of the National Physical Laboratory of England was built by the Bureau[1]. That apparatus has been used to some extent in the industries as well as in government laboratories, and has given excellent service. It contains certain features, however, which render it expensive to build and somewhat difficult to keep in adjustment, especially in a factory where vibrations are excessive. For this reason it was considered desirable to make certain changes of design. Accordingly, in the new type of apparatus, illustrated herewith, the right-angle prism and the mirror have been eliminated and the protractor for measuring the thread angle has been made a component part of the apparatus.

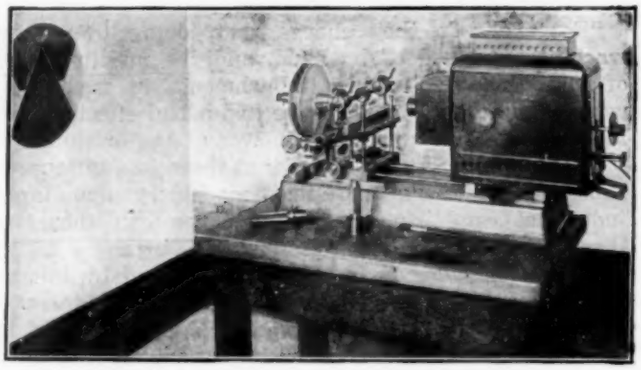
In the new apparatus the image is projected horizontally, and the lens system is such that with three different objectives having focal lengths of 48, 32, and 16 mm., magnifications of 50, 100 and 250 are obtained at a screen distance of about 5 ft. Excellent illumination and sharpness of image are obtained, and the screen distance is such as to give the best of seeing conditions for the operator at the lantern.

The standard angle is located in the microscope tube and its projected image is matched against that of the thread to be measured. Adjustment of the positions of the thread and the standard angle is accomplished by means of the elevating screw, micrometer, and the milled and graduated head. Readings of the angle, to one minute, are made on the graduated handwheel by which the position of the standard angle is controlled.

In addition to the measurement of angles, the apparatus lends itself well to the measurement of the pitch of thread plug gages and other threaded work. It is both rapid and accurate; a combination as rare as it is desirable. In the measurement of pitch, precision gage blocks are used in conjunction with the micrometer. First a setting is made with the image of one edge of the standard angle in coincidence with one side of the thread. A gage block equal in thickness to an integral number of threads is then inserted between the micrometer spindle and the ball end of the center on which the work is held. The work is thereby displaced laterally at right angles to the axis of the lens system by an amount equal to the thickness of the block. If the lead is correct the edge of the standard angle will again be just in contact with the side of the thread. If not in exact coincidence, the amount by which the micrometer must be turned to bring it into coincidence is the error in lead in the number of threads over which the standard angle has been moved.

In actual use of the apparatus a block is inserted between the micrometer and the center before the initial setting as well as at the second setting. For example, to obtain the error in a half-inch interval the 0.1-in. and 0.6-in. blocks would be used instead of no block for the first setting and the 0.5-in. block for the second.

After some practice with the lantern it will be found practicable to use it in the measurement of profiles and templates; and by the substitution of a cradle or other suitable holder in place of the centers, and a notched template representing the tolerance, to use it on production work as is done with the Hartness Screw Thread Comparator.[2] Six of these lanterns have been built for the Ordnance Department, U. S. A. Most of the work of development of the apparatus here described was done in the laboratories of the Gage Section, Bureau of Standards, by D. R. Miller and D. R. Carter.



IMPROVED TYPE PROJECTION APPARATUS

*Published by permission of the Director, Bureau of Standards.

[1](a) Communication B510, Gage Section, Bureau of Standards. (b) Mechanical Engineering (Journal A. S. M. E.), Nov. 1918.

[2]Mechanical Engineering (Journal A. S. M. E.), Feb., 1919.

Applying Magnetic Chucks to Best Advantage

BY AMOS FERBER

C. A. Macready, on page 706 of the *American Machinist*, takes issue with I. A. Hunt, whose article appears on page 267 of the same journal, for the reason that his statements may "mislead prospective buyers who wish to use the magnetic chuck for holding work as accurately as possible."

I am interested in magnetic chucks. I use them to "hold work as accurately as possible;" and I supposed everybody who used them at all did so for the same purpose. I read Mr. Hunt's article with care and it did not mislead me, but, having given the same careful attention to Mr. Macready's statements, I must admit that I am puzzled.

Mr. Hunt states that "a solid auxiliary top plate defeats its purpose;" while Mr. Macready states that he "never made a top plate with the poles insulated . . . ." Does he mean that Mr. Hunt is wrong and a solid top plate is practical? I wish he would tell me what kind of a chuck he uses that will get magnetism enough through half-an-inch of solid cast iron to hold work on top of it; *I* can't do it.

Mr. Macready says: "If one happens to be using a chuck that is not true, a flat piece of cast iron placed on the face of the chuck and trued off will be the quickest way of obtaining a true seat, *if one is able to make use of a pole opposite to the ones in the center of the chuck.*"

All of the chucks that I know (and I thought I knew them all) have both positive and negative poles in the center as well as everywhere else on the holding surface; each alternate pole being of like polarity and the intervening ones of opposed polarity. If Mr. Macready now makes use of a third pole that is opposed to both of them I would like to know about it.

SHOP EQUIPMENT NEWS

-Edited By-
S. A. HAND

SHOP EQUIPMENT • NEWS •
A weekly review of modern designs and equipment

Descriptions of shop equipment in this section constitute editorial service for which there is no charge. To be eligible for presentation, the article must not have been on the market more than six months and must not have been advertised in this or any previous issue. Owing to the news character of these descriptions it will be impossible to submit them to the manufacturer for approval.

• CONDENSED • CLIPPING INDEX
A continuous record of modern designs and equipment

"Ideal" Pneumatic Chip Separator

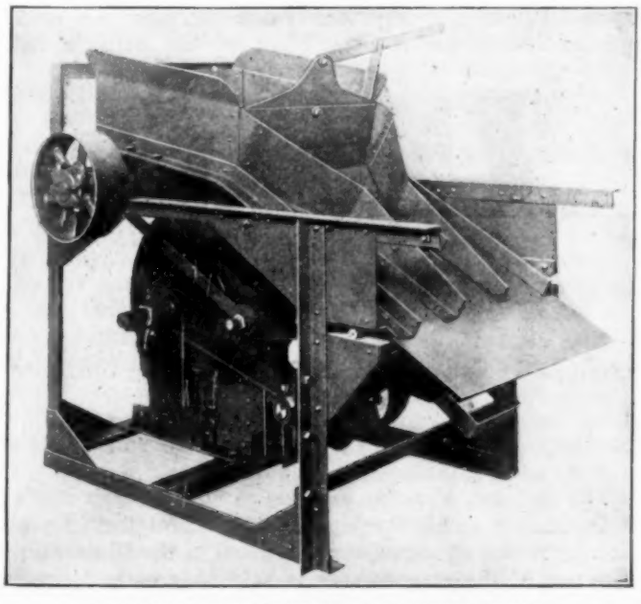
The pneumatic chip separator shown in the illustration has recently been placed on the market by the Ideal Concrete Machinery Co., Cincinnati, Ohio. It is intended chiefly for separating small work, such as screw-machine products, from the chips.

The work is placed or discharged into the hopper on the top of the machine, both the hopper and the incline riveted to it being given a compound vibratory motion. When the control gate is opened, the work slides down the incline to an opening. There the blast from the centrifugal blower floats the chips over the opening, while the machined parts drop through into tote pans. The chips continue down the slide and are collected in suitable boxes.

It is claimed that the separation of the chips by merely floating them across the opening in the slide makes it possible to operate the machine with much less pressure than if the chips were blown up into the air.

Low pressure enables the separation of the chips from small as well as large work. The chips do not pass through any restricted passages, so that clogging is not apt to occur.

The frame is made of angle iron, riveted, and reinforced at the corners by gusset plates. The bearings are lubricated by grease cups or sight-feed oil cups.



"IDEAL" PNEUMATIC CHIP SEPARATOR

Rohde Solders

The Rohde Laboratory Supply Co., 17 Madison Ave., New York City, has recently placed on the market a line of solders, each one intended for use on a certain class of work or material.

For work on sheet aluminum, lap joints, seams and general repairs in aluminum, "Al-Solder" is used. This solder comes in the form of white, deliquescent sticks and contains all of the flux necessary for its use. The parts to be joined must be heated to a temperature between 500 and 600 deg., and then rubbed with the solder, which melts and makes the joint. A chemical action occurs, indicated by the giving off of white smoke, the weld being homogeneous, so that the seams may be made invisible by polishing. The joint is said to resist electrolytic corrosion because of the fact that it consists of almost pure aluminum.

For heavier work on aluminum, or where considerable volume must be filled by the solder, a filler, in the form of metallic sticks, can be used in conjunction with the "Al-Solder," which acts as the flux. The filler is made in six grades, so as to suit different requirements of heat-resistance, strength and material.

A general utility solder is sold under the name of "Tensil" solder, being intended for lapping and joining iron, brass, lead, nickel, tin and zinc. The joined parts must first be tinned with "Al-Solder," and then the sticks of "Tensil" applied either directly or with a soldering iron.

For work on aluminum castings "Nuflux" solder is intended, it being a metallic rod containing its own flux in suspension. It is especially adapted for filling up blowholes and pittings in castings, or for joining cast parts.

For cleaning and de-oxidizing molten aluminum, "Clean-Al" is intended. When it is stirred into the molten metal it partly volatilizes and leaves a gray, dry powder on the surface, which can be easily removed.

For soldering cast iron "Rolasco" solder can be furnished. It can be used either in the granulated or in the stick form with a special flux, there being five grades, so as to suit different conditions and kinds of iron.

The solders vary in melting point from 650 to 1,250 deg. F., the color and the tensile strength also varying. It is claimed that homogeneous joints of great strength are made.

"Silva" solder is of gray color and can be furnished either granulated or powdered. It can be used on non-ferrous copper alloys and is especially intended for work on german silver. It can be altered to obtain the proper

melting temperature and color. The parts to be joined must be heated and the solder applied with a soldering iron, using a special flux.

For use on jewelry and scientific instruments a sterling silver solder is also made, being a white amorphous powder containing its own flux. It is applied directly to the surfaces to be joined, and at a red heat the solder melts and a chemical action yields the metallic silver. The joint is said to have unusual tensile strength.

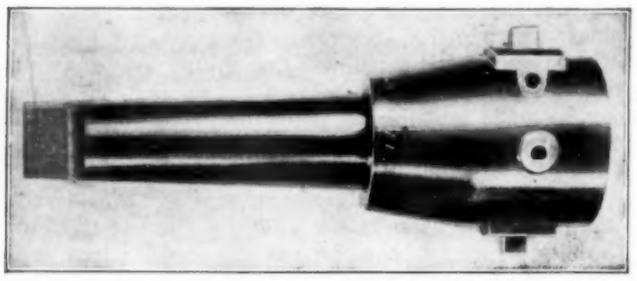
"V V" Expanding Boring Bar

H. A. Hopkins & Co., Inc., La Salle West and La Porte Aves., South Bend, Ind., has placed on the market an expanding boring bar.

This device is known as the "V V" bar because of the shape of the ends of the adjusting screws, one being an external and the other an internal V.

The bar is made in two styles, type "A" being used for holes from 1 to 2½ in. in diameter and type "B," shown in the illustration, for holes from 3 to 12 in. in diameter. It can be furnished with either straight or taper shank and either plain or with a pilot bar.

Square toolbits are used. For the bars boring holes 3 in. in diameter or larger, regular commercial toolbits



"V V" EXPANDING BORING BAR

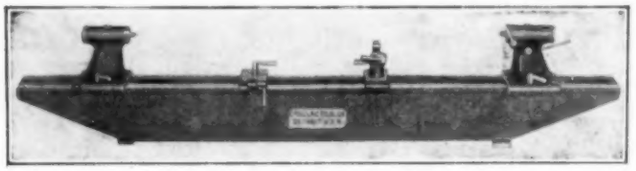
can be utilized, so that worn cutters can be easily replaced.

To change the boring diameter the conical-pointed screw is adjusted. The screw opposite it is then tightened to clamp the cutters in place. It is claimed that the tool is capable of heavy-duty work. Tools requiring a number of cutters can be furnished for special jobs.

Cadillac Bench Centers

The Cadillac Tool Co., 268 Jefferson Ave., Detroit, Mich., has put out a line of bench centers of the type shown in the illustration, the device being built in seven sizes. The bed is a ribbed casting of box-form construction, the ways being scraped.

Both stocks may be moved to suit different lengths of work, and when adjusted can be clamped in place



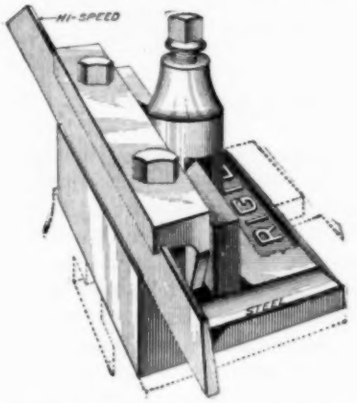
CADILLAC BENCH CENTERS

Specifications: Made in seven sizes: 6 x 18 in., 6 x 36 in., 9 x 36 in., 9 x 48 in., 12 x 36 in., 12 x 48 in., and 12 x 60 in.

by means of levers. The right stock has a spring-actuated spindle that engages the work with sufficient pressure to eliminate play or lost motion between the centers. A fixture for holding a dial indicator is fitted to the bed. The 9- and 12-in. swing bench centers are furnished with stock rests also.

Rigid "Back-Stroke" Cutting-Off Tool

The Rigid Tool Holder Co., Washington, D. C., has recently placed on the market the cutting-off tool and holder shown in the illustration. The device consists



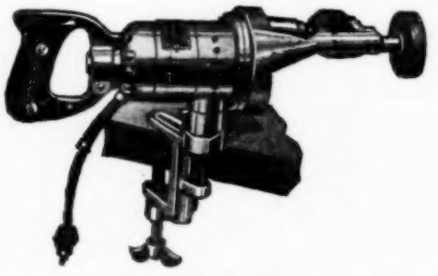
RIGID "BACK-STROKE" CUTTING-OFF TOOL

of a narrow tool of high-speed steel held by a hardened steel clamp on the base of the holder, which is a steel casting.

The tool can be held by the toolpost of a lathe and swung to cut on either the right or the left, the cut being made from the rear. It is claimed that the blade is always held erect and that it can work very close to a chuck or steadyrest.

Grinder Attachment for Arnold Portable Drill

The Arnold Electric Tool Co., Inc., New London, Conn., and 114 Liberty St., New York City, has placed on the market a grinder attachment for its type-B portable electric drill. The frame carrying the wheel spindle is clamped to the body of the drill, a belt



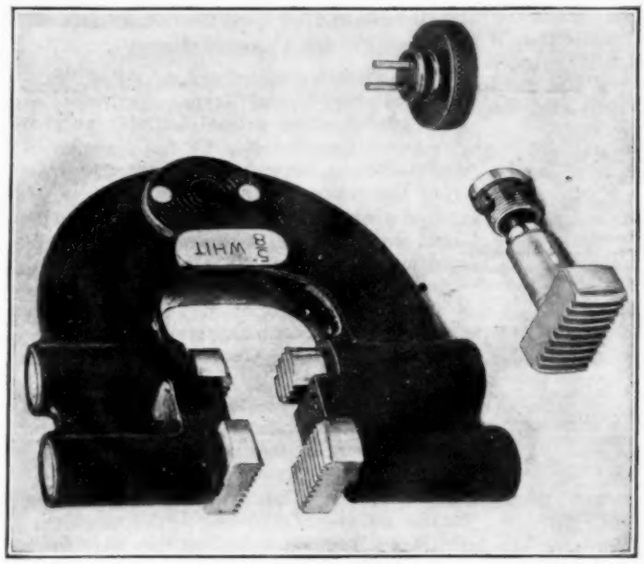
ARNOLD TYPE-B DRILL WITH GRINDING ATTACHMENT AND CLAMP

running on the sleeve of the chuck transmitting the power to the spindle.

The tool can thus be used as a portable grinder, or it becomes a small bench grinder by clamping in position by means of a bracket, as shown in the illustration. The use of the attachments is said to greatly increase the field of application of the tool.

Wickman Adjustable Thread Snap Gage

Alfred Herbert, Ltd., Coventry, England, and 54 Dey St., New York City, has recently placed upon the market the Wickman adjustable snap gage for measuring threads. The body of the gage is the same as used for plain snap gages, the U-shaped frame being made of cast iron and ribbed to prevent deflection. The heads



WICKMAN ADJUSTABLE SNAP GAGE FOR THREADS

are bored on a special fixture and finish lapped to insure alignment.

The anvils are grooved to suit the pitch which is to be measured, two sets of them being used at a time. Since the gages are adjustable for diameters, the straight teeth of the anvils have to be correct only in the form of the thread and in the pitch. The anvils are cut with a hob, and then lapped to a finish, testing for form being done by projection.

The front and the rear anvils are different in form. The teeth of the front set are made to conform exactly to the profile of the screw thread. They insure that work which passes between them will assemble in a hole in which a standard plug screw gage will fit. One way of setting the anvils the proper distance apart is to fit between them the tap with which the threads in the hole being fitted are made. The gage can be held up toward the light in order to determine how accurately the thread on the screw fits the teeth of the gage, which is a "go" gage.

In case the work has a slight error in pitch and yet passes the front gage, due to having an effective diameter smaller than standard, the thread will be thinner than normal. As it is necessary that a limit be placed on this thinning, the second or inner set of anvils is used to detect thin threads. These anvils have clearance on the tops and roots of the threads so that they test only the flanks of the thread and the effective diameter of the screw. By spacing these anvils some predetermined amount below standard size, it is possible to set a limit to this thinning of the thread. The inner anvils then form a "no-go" gage, because the work is rejected if it passes between them. Testing in this way is thus much more complete than by merely using a ring gage on the screw.

The gap between the anvils can be adjusted with an accuracy of 0.0001 in., each anvil having an adjustment of $\frac{1}{8}$ in. Sets of frames are thus made in $\frac{1}{4}$-in. steps, the anvils for all pitches being interchangeable in them. It is thus possible to gage screws of any diameter and with any limits required. The distance from the top of the thread to the pitch diameter is marked on the "no-go" anvils, so that, with the help of plugs or gage blocks, it is possible to accurately determine and set the pitch diameter of the gage.

The anvils are prevented from turning by the lug between them. No screws or pins are exposed, the adjusting screws being underneath the locking screws, which are covered by lead seals. The seals are put in place by a special press, which monograms them.

A Pair of Old Pulleys

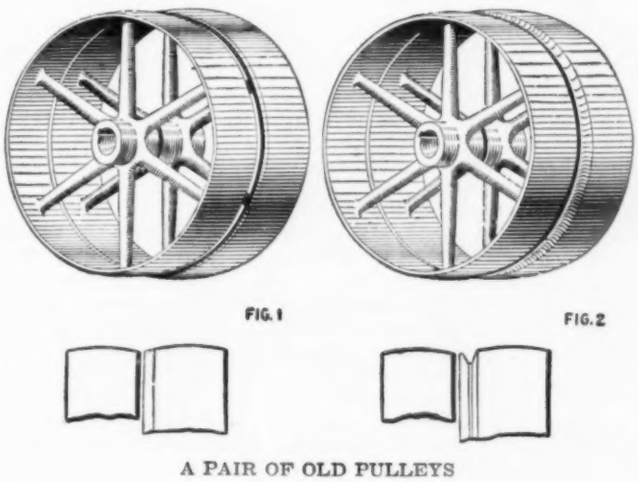
By W. Burr Bennett

The writer recently ran across the remains of an old machine of unknown origin in a junk dealer's yard. Idle curiosity prompted him to look it over and the design of the tight and loose pulleys on the relic was something new to him.

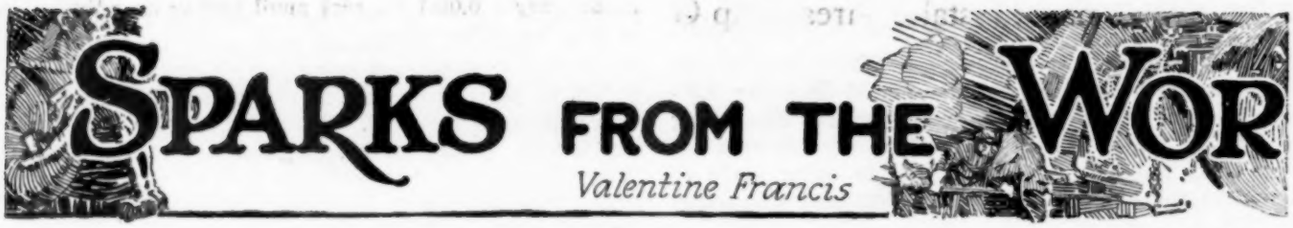
Although practically nothing of the machine remained except a leg and the bracket with the attached shaft and pulleys, something in the general design suggested that the machine was one used in textile work of some sort.

Fig. 1 shows a sketch of the common tight and loose pulley arrangement with the tight or driving pulley slightly larger than the loose pulley so as to take up the slack belt. Usually this tight pulley has a slight incline or bevel for the belt to run up on when shipping. However on this old machine the arrangement was as shown at Fig. 2; that is, a deep groove has been turned in the tight pulley and so formed as to have a comparatively sharp edge at the low part of the crown of this pulley.

The writer can see no particular value to the design as the belt would have to climb the bevel the same as in the later designs and it certainly increases the amount of machine work and the weight of both this pair as well as the driving pulley. The floral and other artistic work on the spokes as well as the climbing arbutus design on the bracket supporting the shaft would indicate that the parts were made anywhere from fifty to a hundred years ago, and this may account for the peculiar groove. Each pulley had a 2-in. driving face and the total width of the tight pulley was about 3 in. The diameter was slightly less than 10 in.



A PAIR OF OLD PULLEYS



Many U. S. Companies Represented in Spain by H. S. Moos

Henry S. Moos, M.E., has returned to Spain to present to Spanish users American machine tools and machinery. While in America Mr. Moos, in behalf of his associated companies, the American Machinery Corporation, S. A. E., Madrid, and the Sindicato de Maquinaria Americana, Bilbao, made arrangements to represent, among others, the following manufacturers: American Tool Works Co., American Woodworking Machinery Co., American Broach & Machine Co., Avey Drilling Co., Anderson Die Machine Co., Barnes Drill Co., Cincinnati Electric Tool Co., Cincinnati Machine Tool Co., Colburn Machine Tool Co., Detroit Electric Furnace Co., Foster Machine Co., Davis Machine Co., Heald Machine Co., Hercules Machine Co., E. Horton & Son Co., Hoefer Mfg. Co., Macleod Co., Newton Machine Tool Works, Oesterlein Machine Co., McMyler Interstate Co., Jos. T. Ryerson & Son, Rouillard Tool Co., Robertson Machine & Foundry Co., Standard Engineering Wks., Standard Tool Co., D. H. Stoll, J. D. Wallace Machine Co., Watson Stillman Co., Willard Machine Co., Webster & Perks Tool Co., Wilmarth and Morman Co., U. S. Light and Heat Corporation, Atlas Car and Manufacturing Co., American Manufacturing Co., American Road Machinery Co., Wardwell Manufacturing Co., Curtain Supply Co., Globe Electric Co., Universal Abrasive Products Co., High Speed Hammer Co.

Mr. Moos and the engineers associated with him will attend to the inquiries and engineering needs of the Spanish industry. American machines will be demonstrated in practical operation in the showrooms of the two companies and important stocks of machines and tools will be carried in order to give service to customers.

Metric System Not Wanted in British Optical Industry

The metric advocates have always claimed the optical industry as thoroughly standardized on the metric system. The grinding of lenses especially was claimed to be done exclusively on the millimeter basis of the metric system.

This erroneous contention is positively refuted in the report of the Department of Scientific and Industrial Research, 16 and 18 Old Queen St., Westminster, London, S. W. I.

This report, dated August, 1920, is the result of investigations made by a committee representing the following organizations: The British Optical Instrument Manufacturers' Association, the British Admiralty, the British War Office, the British Air Ministry, the National Physical Laboratory and the Imperial College of Science and Technology.

Limited space allows us to give only the following quotations:

The first matter considered by the committee was the fundamental question of unit of measurement of length.

The statement that changing from inch to metric measurement would facilitate foreign trade was considered by the committee, but the evidence of manufacturers showed that foreign trade was affected but little by the unit of measurement used in manufacturing.

The established practice of British lens makers has generally been to manufacture lenses on the inch basis, but, when selling them to metric countries, to quote focal lengths and diameters in millimeters, and this satisfies practical requirements.

Substantially, all materials are made and sold in terms of the inch. The same is generally true of tools.

The standards of the British Engineering Standards Association applicable to optical instrument making, with the exception of B. A. screw threads, are all based upon inch measurement.

So far as optical work is concerned, computations are generally made, in the first instance, in terms of unity and not in terms of any specific unit of measurement and can be translated into terms of the inch or the meter with equal facility.

But in order to avoid the confusion which would result from employing a mixed system of units the committee decided that the unit used for optical work must be the same as that used for mechanical work

The committee therefore recommends that the British inch should be retained as the unit of length for the purpose of standardization and manufacture of all parts of optical instruments.

Sale of Decapod Locomotives

The Director of Sales, War Department, announces that forty-four decapod locomotives, a portion of those originally built for the Imperial Russian Government, 100 of which already have been purchased and now are in operation on American railroads, are to be sold at a fixed price of $25,000 each. They are to be sold to Americans for use on American railroads. The decapods have been altered to operate on a standard gage track.

The decapods are located at Tullytown Arsenal, Tullytown, Pa. The purchase price may be divided into ten annual instalments, with 6 per cent on deferred payments.

Who Can Answer This One?

We are in receipt of a letter of inquiry from a correspondent who desires important information. Here it is:

If you have any idia how it is posible to make a perpetul motion machine it will be gratly apreciated. Any charge to be made charge to the writer if you can't answer these question let me know who does it.

Resp.

[We haven't! We can't! We hate to confess our ignorance but we must pass the buck to our readers.—Editor.]

Chamber of Commerce Bulletin on Cancellations

A summing up of the so-called "cancellation evil" and its possible remedies is contained in a final bulletin on this subject issued today by the Fabricated Production Department of the Chamber of Commerce of the United States.

An exhaustive study of the practice of cancellation of orders and repudiation of contracts in almost every division of business has been made by the Fabricated Production Department, as a result of which study it groups opinions as to possible causes under these three heads:

"First: That the practice is the result of war-time irregularities and will pass as we return to a normal basis.

"Second: That we are now reaping the results of the loose business practices inaugurated before the war, when many lines were in a state of overproduction and the measures taken to unload this surplus were demoralizing. Those entertaining this belief feel that the remedy is in a general reformation of our system of order taking, making each order a contract enforceable by law.

"Third: That we have been drifting away from the fundamentals of sound business and the 'Golden Rule,' and that we must return to a stronger belief in the rights of others and a higher regard for our own integrity if the change is to be permanent."

In suggesting the possible remedy for this cancellation evil the bulletin says: "There is a strong feeling that this thing must end and to that end many trade organizations have met and formed committees and bureaus to deal with it.

"The Credit Co-operative and Credit Methods Committee of the National Association of Credit Men has met twice to consider it, and it suggests truly that there seems to have been a dulling of public conscience. Should one who habitually repudiates his contrats and orders be given a higher credit rating than he who lets his notes and drafts got to protest? They also feel that one remedy, and as a safeguard against the unscrupulous, would be that each line of trade should at once examine its contract making and order taking methods to bring them strictly within legal lines. This is practical and can be immediately applied.

"We feel, however, that perhaps the most effective remedy must be the one that will call us back to 'first principles,' to where we can 'point with pride' to our house as one that 'fills its orders and keeps its contracts.'

LD'S INDUSTRIAL FORGE
News Editor

American Engineering Standards Committee Elects Officers

At the annual meeting of the American Engineering Standards Committee held in New York on Dec. 4, A. A. Stevenson, a representative of the American Society for Testing Materials, was re-elected chairman for 1921, and George C. Stone, a representative of the American Institute of Mining and Metallurgical Engineers, was re-elected vice-chairman.

The following were also elected to represent the respective member-bodies on the Executive Committee: Comfort A. Adams, American Institute of Electrical Engineers; Martin Schreiber, American Society of Civil Engineers; Fred E. Rogers, American Society of Mechanical Engineers; A. H. Moore, Electrical Manufacturers Council; Dana Pierce, Fire Protection Group; A. Cressy Morrison, Gas Group; N. A. Carle, National Electric Light Association; Albert W. Whitney, National Safety Council; Coker F. Clarkson, Society of Automotive Engineers; Thomas H. MacDonald, U. S. Department of Agriculture; E. B. Rosa, U. S. Department of Commerce; O. P. Hood, U. S. Department of the Interior; Francis J. Cleary, U. S. Navy Department; J. H. Rice, U. S. War Department; American Electric Railway Association (official representative not yet designated).

There are now forty-seven members of the committee, representing seventeen member-bodies. Twenty-four organizations in all are represented on the committee, as three of the member-bodies are groups of organizations.

"There are many in all lines who have through all this upheaval stood steady and right—preferring to take loss rather than mar a lifetime record of good performance.

"The advertising men redeemed their line from discredit by standing for 'clean advertising'—it means a loss of business and money to those who pioneered it, but the fight was won and it paid.

"What shall the 'slogan' be that can be used in a countrywide campaign to clean up unjust cancellations, broken contracts and bad faith? We will have one, but you have an opportunity to suggest it now.

"Before we legislate for the other fellow let there be a pause for self examination—will we do what we expect our customers to do? The department in this matter feels it is representing the best interests of the chamber membership in placing this situation before them and asking for their direction."

E. C. Morse Awarded Distinguished Service Medal

For his work in connection with disposing of the hundreds of millions of dollars of surplus war stocks Ernest C. Morse, Director of Sales, War Department, who retires from the service on Dec. 31, has been awarded the Distinguished Service Medal. The award was made to Mr. Morse and the medal presented to him by Secretary of War Baker in Washington on Dec. 7.

During Mr. Morse's term of office as Director of Sales more than $1,750,000,000 worth of supplies have been disposed of. The percentage of recovery was greater by far than that of any country or government—63 per cent.

ERNEST C. MORSE

The official order issued by the War Department regarding the award says: By direction of the President, the Distinguished Service Medal is awarded the following named civilian:

"Ernest C. Morse, Director of Sales, Supply Division, General Staff, for exceptionally meritorious and distinguished service. Charged with the very important duty of organizing and training a competent force for the entirely novel functions of supervising, co-ordinating and directing the disposal, according to law, of the vast War Department surplus of supplies, materials and properties of every description, and with the formulation and development of sales policies, he performed his manifold duties with marked ability, energy and judgment, with the result that the United States disposed of great quantities of supplies at exceptionally advantageous prices."

National Museum Gets Early Automobile

The National Museum at Washington, D. C., has just received and placed on exhibition in the Arts and Industries Building, the second gasoline automobile designed and constructed by Charles E. Duryea, between September, 1892, and September, 1893, at which latter date the machine was successfully operated. The acquisition of this most interesting object was made possible through the generosity of Inglis M. Uppercu, president of the Detroit Cadillac Motor Car Co. of New York City. Although the machine on exhibition is not the first car made by Duryea (the first being designed and built between August, 1891, and September, 1892, and successfully operated) it is a duplicate of it except in having a more powerful motor and correspondingly heavier and stronger parts.

Just as in the very beginning of railroad transportation, the passenger coaches used were simply stage coaches mounted on wheeled trucks, so Duryea's first and second automobiles were simply converted horse-drawn carriages, the particular style chosen being the lady's low phæton. Every part of the carriage was used, simply adding to it the engine and propelling and control mechanisms.

The motive power of the vehicle is a single cylinder, four cycle, water-cooled gasoline engine designed by Duryea. The engine, whose piston rod and crankshaft are both exposed, lies horizontal with its head toward the rear of the carriage and the crankshaft and flywheel located at the center of the vehicle below the seat. The engine is fired by a make-and-break spark, a pin attached to the center of the piston head striking a pivoted arm which in turn is in contact with an insulated connection through the cylinder head to the source of the electric current (dry batteries). The carburetor is of the spray type but without a float such as is generally used today and fuel was fed into the float chamber at a rate which would give maximum power at the desired speed, the motor being operated at a constant speed as it was thought at that time that a gasoline engine could not be throttled. There is an overflow line in this so-called carburetor, so that if the speed of the engine slowed down, the excess gasoline would flow out into a tank below from which it could be returned to the supply tank by means of a hand pump. The starting crank projected at the rear parallel to the engine cylinder and turned the crankshaft by engaging a pair of bevel gears on the upper face of the flywheel.

Attached to the center of the under face of the flywheel is a bevel gear which engages two gears on a horizontal shaft. Through small friction clutches this horizontal motion is transferred through rawhide gears to a jack shaft, at the ends of which are small sprocket wheels, which are connected by bicycle chains to large sprocket wheels secured to the inside of the spokes of the rear wheels of the carriage. In addition, on this jack shaft there is a small differential enclosed in a housing, being almost a miniature of the modern differential. There are two clutches attached to the main driving shaft, one for forward motion, and one for reverse. They are controlled by an up-and-down motion of the steering tiller, through wires over pulleys controlling a sliding cam, which engages and disengages the clutches.

The steering mechanism is of the tiller type, the left and right motion being transferred through a radius rod to C-type steering knuckles. The pivot line of these knuckles intercepts the plane of the wheels at the ground, a feature which is still found in the designs of modern automobiles. The whole power plant is supported on a chassis, the rear end of which is held by two rods attached to the extremities of the rear axle and the forward end supported at a single point on the front axle, forming a sort of pivot and resulting really in a three-point suspension.

This machine was used about Springfield during the winter of 1893 and spring of 1894 and, in the meantime, another machine was being built—this one to be a real automobile. This third machine was running late in 1894 and won the first American Automobile Race, Thanksgiving Day, 1895, at Chicago.

Four California Firms Join $5,000,000 Machine Merger

Formation of a $5,000,000 corporation for the manufacture of machinery for canners and dried fruit packers is announced by the Berger & Carter Co. interests of San Francisco. The new company will be known as the Berger, Fleming & Brown Co., and will have its main offices and factories at San José.

The new corporation absorbs the following companies: Berger & Carter Machinery Co., of Hayward, Cal., manufacturer of fruit and vegetable canning machinery; Smith Manufacturing Co., San José, Cal., manufacturer of machinery and equipment for packers of dried fruit; Wonder Dehydrator Co., San Francisco, manufacturer of "Wonder" portable and custom dehydrators, operating under the Hammond process patents; National Axle Corporation, San José, Cal., manufacturer of auto-truck axles.

Really big men love to lock arms with difficulties that would floor weaklings. They find joy in heroic effort.—*Forbes Magazine* (N. Y.)

Export-Trade Combinations Now Operating

The Federal Trade Commision today announced that forty-five export associations, or combinations organized for the purpose of export trade, are now operating under the Export Trade Act (Webb-Pomerene law), of which law the commission has administration.

The far-reaching effect of the Export Trade Act upon national industrial life may be seen from the fact that these associations comprise a total of 772 members, whose plants and factories, numbering about a thousand, are distributed over forty-two states of the Union. In some of the larger plants thousands of workmen are employed; others are so small that exportation would be impossible without the advantages of co-operation derived under the act.

The products exported include a wide range of commodities, from clothespins to locomotives, and are shipped from both Atlantic and Pacific ports to every part of the world.

Industrial Machinery in France and Belgium

"Europeans have overestimated their capacity for rehabilitating their industries; American co-operation applied to the reconstitution of essential producing industries would provide a considerable market for American industrial machinery and at the same time would insure raw materials and more work for European machinery factories; more needs to be done to gain the confidence of European industrialists." The foregoing are the expressed opinions of Trade Commissioner Charles P. Wood in a report on industrial machinery in France and Belgium just published by the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

The report is published in answer to the many inquiries received in the Bureau of Foreign and Domestic Commerce from American machinery manufacturers, engineers and contractors concerning the probable requirements of European countries that would seek to rehabalitate their industries and resume their former status in the peace-time markets of the world Every important industrial center and such other places as would contribute to a broad estimate of the situation were visited by Mr. Wood during the course of his investigation.

The report discusses industrial conditions after the war. The industrial needs of the two countries are classified for the convenience of the manufacturer and exporter. Application of American methods, credits and trade methods generally are covered at some length.

The publication is known as "Special Agents Series No. 204—Industrial Machinery in France and Belgium." Copies can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., and from the district and co-operative offices of the Bureau of Foreign and Domestic Commerce located in different cities.

Engineers Hear of Deep Sea Diving

At a joint meeting of the Harvard, Yale and Princeton Engineering Associations held at the Yale Club in New York on Dec. 9, John F. O'Hagan, formerly of the United States Navy, told of the development of the art of deep sea diving from the days of Homer to the present day. He had a complete modern diving suit with him and explained its workings in detail, assisted by Frank Crilley, the holder of the depth record of 306 feet made at Honolulu in his endeavor to rescue the crew of the submarine F-4. The engineers were willing to accept the classification of diving as an extra hazardous occupation after listening to Mr. O'Hagan's description of the fatal "squeeze" of hydrostatic pressure and the tortures of caisson disease, or the "bends."

Obituary

Horace E. Dodge

Horace E. Dodge, millionaire automobile manufacturer, died unexpectedly on Dec. 10 at his winter home in Palm Beach, Fla., where he had gone, apparently in good health, from Detroit a few weeks ago. He was fifty-two years old.

Mr. Dodge has been sole head of the Dodge automobile interests since his elder brother, John Dodge, died in New York at the Ritz-Carlton last January of pneumonia. At that time Horace E. Dodge also was seriously ill with pneumonia. The brothers were attending the New York automobile show together, where they were both stricken.

On completing their apprenticeship in the parental shop the brothers worked as journeymen machinists in several Michigan cities until the year 1901, when they started their own place in Detroit. They employed only eleven men and used machinery taken in payment of a debt. They then began to specialize—John becoming the business executive and Horace the technical expert on gas engines.

When Henry Ford organized his company in 1902 he took the Dodge brothers in with him for a combined interest of $10,000, the stock to be paid for by their manufacture of 650 chassis. In 1916 they won an action against Mr. Ford to restrain him from what they considered misuse of the company's profits. They then started to manufacture their own cars.

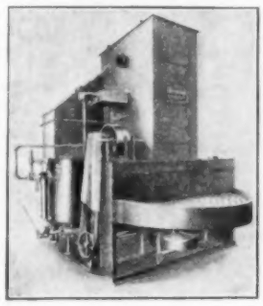
A few years ago the brothers gained a rapid success in the manufacture of the Dodge car. They were popular with the 18,000 men who worked for them; the day after the death of John Dodge the organization paid him the tribute of breaking all production records for the plant.

Mr. Dodge is survived by his wife and two children.

Condensed-Clipping Index of Equipment

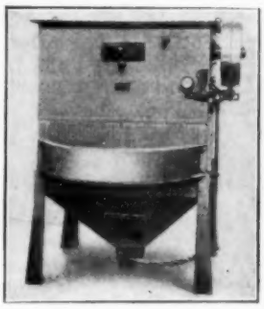
Patented Aug. 20, 1918

Sandblast, Rotary-Table, Direct-Pressure-Type
Pangborn Corporation, Hagerstown, Md.
"American Machinist," Nov. 18, 1920



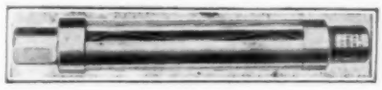
This machine is used for work difficult to clean and of large size. It is equipped with an elevator and a separator, using both mechanical means and circulation of air for reclamation and separation of the abrasive. The reclaimed abrasive is accumulated in storage bins, from which the tank for the blast can be quickly refilled by operating a valve, thus making the operation of the machine practically continuous. The machine is made in two sizes, with table diameters of 70 and 90 in. and a clearance of 15 in. between the table top and the nozzles.

Sandblast, Rotary-Table, Suction-Feed, 42-In.
Pangborn Corporation, Hagerstown, Md.
"American Machinist," Nov. 18, 1920



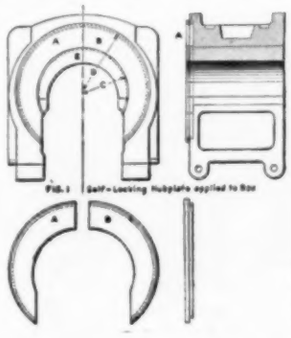
The self-contained suction-feed machine is intended for the cleaning of light work and refinishing. The used abrasive is reclaimed through screens and handled without the use of an elevator. The cleaned abrasive is carried continuously by suction to the nozzles. The machine is made in two sizes, the one shown having a table 42 in. in diameter and one nozzle with a vertical adjustment allowing any distance from 5 to 12 in. between the table top and the nozzle.

Mandrel, Self-Gripping
Eastern Tube and Tool Co., Inc., Brooklyn, N. Y.
"American Machinist," Nov. 18, 1920



The mandrel shown holds bushings, gears and similar parts while turning or grinding, the parts being slipped on or off it by turning them slightly to the left. The body has three grooves, each of which contains a roller in the proper position for gripping by means of flat springs. The collars at each end retain the rollers and springs. When the cut is applied to the work on the mandrel the rollers are caused to wedge and grip the work rigidly. The body is ground 0.0002 in. undersize. Due to the action of the rollers, the mandrel will grip work 0.005 to 0.015 oversize. The mandrel is made in a range of sizes from ¼ to 2 inches.

Hub Plate, Self-Locking
J. P. Finerty & Co., Dunmore, Pa.
"American Machinist," Nov. 18, 1920

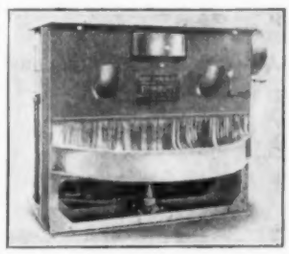


This self-locking hub plate has been designed to replace the methods of putting in hub liners which are now in use. It does away with the method of casting the hub plate into the driving box and also of fastening it in by screws or similar methods. Hub plates of this type are in use on about forty locomotives of a well-known railroad and are giving satisfactory service at a considerably lower cost than the plates formerly used.

Sandblast, Rotary-Table, Gravity-Feed-Type
Pangborn Corporation, Hagerstown, Md.
"American Machinist," Nov. 18, 1920

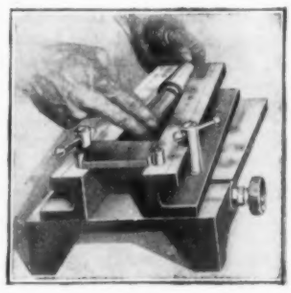
This type of machine is intended for work not difficult to clean or where the intensive action of the direct-pressure blast is unnecessary. The machine is self-contained. Both mechanical and draft action are used for reclamation and handling of the abrasive, which is fed by gravity in a continuous cycle to the nozzles. The machine is made in but one size with a table diameter of 84 in., and it has an adjustment of the nozzle arms that permits a clearance of either 10 or 15 in. between the table top and the nozzles.

Sand-Blast, Rotary-Table, Suction-Feed, 70-In.
Pangborn Corporation, Hagerstown, Md.
"American Machinist," Nov. 18, 1920



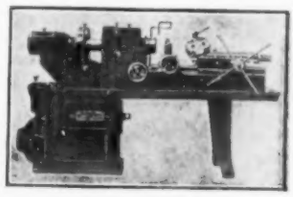
This is the largest size of suction-feed machine of the series. It has a table diameter of 70 in. with a clearance of 12 in. between the nozzles and table top, allowing the handling of reasonably large work or a large quantity of small pieces.

Gage, Taper-Measuring, "Precision"
Doyle-Wall Machine and Tool Co., 318-24 Pearl St., Syracuse, N. Y.
"American Machinist," Nov. 18, 1920



The device consists of a double sine bar and angle-measuring gage. Tapers from 0 to 4 in. per foot can be measured. A chart, figured to four points of decimals, is supplied with each gage to show the values of tapers from ⅛ to 4 in. per foot. The gage can be set up more quickly than a sine bar, and no high degree of skill is required for its operation, because only one measurement is necessary. The parallels and pins are hardened, ground and lapped, an accuracy to within 0.0001 in. being guaranteed. The tool is regularly made in two sizes with parallels having 12 or 6 in. center distances, but gages for any desired size of taper can be furnished.

Motor Drive, Lathe, Wood-Turret
Wood Turret Machine Co., Brazil, Ind.
"American Machinist," Nov. 18, 1920



Designed for use on the company's tilted-turret lathe and screw machines, the motor base or cabinet leg of this machine is so arranged that the motor may be easily removed for cleaning or repair. Power is transmitted from the motor to the large driving pulley on the spindle by means of a double belt passing through the pan and lightened by a double-acting idler. This motor-drive arrangement is being supplied on the Nos. 2, 3 and 4 back-geared type of machine, d.c. variable-speed motors being used.

Clip, paste on 3 x 5-in. cards and file as desired

Personals

MAX MAAG of Zurich, Switzerland, inventor of the gears and machines that bear his name, sailed for home on Dec. 4 after several weeks in this country spent in looking after his gear interests here. He expects to return in the spring.

J. C. KOPF, formerly manager of the engineering department of the Duff Manufacturing Co., Pittsburgh, Pa., has been appointed research engineer and placed in charge of a newly established research department. F. W. SCHWERIN has been promoted to manager of engineering.

HARVEY A. HIGGINS, JR., who was connected with the Committee on Public Information during the war and who has recently been doing editorial work in New York City, has returned to his position as advertising manager of the Standard Tool Co., Cleveland, Ohio, from which he had a leave of absence.

JOHN B. MATTHEWS, consulting engineer and surveyor, San Francisco, is now designing the first large turbo-electric driven passenger and cargo steamer to be built on the western coast, and will have entire supervision of its construction.

LEE H. BENSON has been appointed president and general manager of the Amery Manufacturing Co. of Amery, Wis., recently organized by him and other business men of Amery. The company has taken over the entire stock of the Western Machine Manufacturing Co. of Eau Claire, Wis., and will manufacture the line of engines, pump jacks, wood saws, engine trucks, etc., formerly manufactured by that company.

WILLIAM R. MILLER has left the employ of the Hooven, Owen, Rentschler Co., Hamilton, Ohio, and is now with the New York Shipbuilding Corporation, Camden, N. J.

W. R. WEBSTER has resigned his position as assistant chief engineer for the Cambria Steel Co., Johnstown, Pa., to become general engineer of the Semet-Solvay Co., of Syracuse, N. Y.

F. G. B. ALLAN, of Toronto, has been appointed general manager of the Pressed Steel Metals Co. of Canada, Ltd., and American Bushings Corporation, in succession to J. W. Leighton, who is now chief engineer and supervisor of works. In addition Mr. Leighton will devote a portion of his time to the development of the patented bushings and tube processes.

CHARLES SMITH, chairman of the board of directors of Landers Frary & Clark, arrived in New York Saturday on the Aquitania from England. He said that conditions in London are at the present time far from encouraging due to the lack of employment.

W. A. MAXWELL, JR., of Westmont, Pa., assistant general superintendent of the Cambria Steel Co., Johnstown, Pa., resigned, effective Nov. 22, to accept the position as general superintendent of the Inland Steel Co. plant at Indiana Harbor, Ind. H. A. Berg, also of Westmont, superintendent of the blast furnace operations of the Midvale Steel and Ordnance Co., succeeds Mr. Maxwell.

BENJAMIN C. JONES has been selected as general manager of the new porcelain plant division of the General Electric Co. at Pittsfield, Mass.

E. E. HARKNESS has recently been appointed production manager of the C. J. Root Co., of Bristol, Conn, manufacturers of automatic counters, wrought brass hinges, etc.

W. W. ALEXANDER, who has been vice-president and general manager of the Syracuse plant of the John Deere Plow Co., has been promoted to be vice-president and general manager of the company in St. Louis. Upon leaving, Mr. Alexander was presented with a solid gold watch and chain by the employees of the Syracuse factory. Previous to coming to Syracuse in 1910 Mr. Alexander had charge of the Indianapolis branch of the company.

JOHN C. PANGBORN, vice-president, Pangborn Corporation, Hagerstown, Md., manufacturer of sand-blast and allied equipment, sailed on Nov. 27 for Southampton.

J. GRADY ROLLOW has resigned his position with E. I. duPont de Nemours & Co., and is now connected with the Los Angeles Gas and Electric Corporation as consulting engineer.

C. C. LANCE, formerly shop engineer for the Seaboard Air Line Railway Co., is now with the National Boiler Washing Co., Chicago, Ill.

ALBERT R. DISMUKES has resigned his position with Joseph E. Lowes, Inc., Dayton, Ohio, and become associated with the Safe-Cabinet Co., of Marietta, in the capacity of industrial engineer.

RAY MAYHEW, recently motor engineer with the American Hoist and Derrick Co., St. Paul, has taken a position with the Clyde Iron Works, Duluth, Minn.

EDWARD PAYSON BULLARD, JR., president of the Bullard Machine Tool Co., Bridgeport, Conn., has been awarded the Howard N. Potts Gold Medal by the Committee on Science and the Arts of The Franklin Institute for his invention of the Mult-Au-Matic Machine Tool.

FRANK THORNTON, JR., chief engineer of the Westinghouse Electric Products Co., has been appointed manager of the electric heating engineering department of the Westinghouse Electric and Manufacturing Co.

Federal incorporation of American companies doing business locally in China, with exemption of such companies from income and excess profits taxes, is being advocated by American Chambers of Commerce in China, especially those at Shanghai and Tientsin.

Business Items

The consolidation of Whiting Foundry Equipment Co. of Harvey, Ill. and the American Foundry Equipment Co. of New York City, recently announced, has not been consummated and the two companies will continue as separate concerns the same as heretofore.

The Western Reserve Motor Car Co., Leavittsburg, Ohio, has been incorporated for the purpose of manufacturing complete high-class automobiles. R. K. Johnson is president. The Western Reserve National Bank, Warren, Ohio, is the temporary headquarters.

The Production Equipment Co. has opened a showroom at 39th St. and Broadway, New York City, displaying an assortment of rifles, guns, micrometers and other products of the Birmingham Small Arms Co. It also exhibits some interesting small lathes and milling machines made by the Drummond Co. of England.

The Yougstown Steel Co., Warren, Ohio, has been formed for the purpose of manufacturing a high-grade wrought iron by a new process.

A syndicate, composed of Charles Michaels and other Bucyrus capitalists, has purchased the electric crane department of the Toledo Bridge and Crane Co., of Toledo, and a new company known as the Toledo Crane Co., of Bucyrus, will be organized with an authorized capital of $500,000 to operate the business. The plant will be moved to Bucyrus within 60 days.

The Marine Iron Works, New Orleans, La., is quartered temporarily in three old buildings and contemplates the erection of a modern structure on the present site.

The White Manufacturing Co., Goshen, Ind., has recently been incorporated in that state and has purchased the shop and business of the Alford Motor and Machine Co. and the Goshen Motor Works.

Forthcoming Meetings

The Society of Automotive Engineers will hold its annual meeting on Jan. 11 to 13 inclusive at New York.

The Engineering Institute of Canada will hold its thirty-fifth annual meeting in Toronto, King Edward Hotel, on Feb. 1, 2 and 3.

A triple convention of the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association will be held in Atlantic City, N. J., May 16, 17 and 18, 1921, with headquarters for all three associations at the Marlborough-Blenheim. F. D. Mitchell, 4106 Woolworth Building, New York, is secretary of the last-named association.

The Spring Convention of the National Machine-Tool Builders' Association will be held on Thursday and Friday, May 19 and 20, at Hotel Traymore, Atlantic City, N. J. Chas. E. Hildreth, care of the Association, Worcester, Mass., is general manager.

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Grinding Machine, Internal and Spindle

Jones & Shipman, Ltd., Leicester, England.

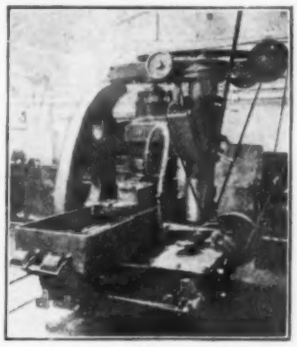
"American Machinist" (European Edition), Sept. 4, 1920.

This machine is intended for all kinds of cylindrical work. External grinding can be done up to 24 in. between centers and 12 in. in diameter and holes from 8 in. up to 5 in. in diameter and 3½ in. deep. Eight spindle speeds can be obtained. To give a wider range of speeds on the workhead a new sectional pulley is fitted.

Grinding Machine, Surface, Vertical-Spindle

Lumsden Machine Co., Gateshead, England

"American Machinist" (European Edition), Sept. 4, 1920.

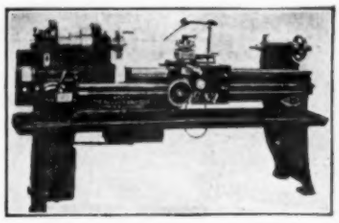


The table of this machine has a working surface of 15 x 72 in.; it is driven by rack and spiral gear. The traverse speeds are 8 ft. and 13 ft. per minute, the reverse motion being automatic. The 16 in. in diameter grinding wheel is built up of eight segmental blocks held by taper dogs in a chuck; the segments protrude from the chuck about ½ in. The minimum feed of the wheel is 0.0005 in. and the maximum, 0.008 in., both hand and automatic feed being provided. Weight, 6½ tons; floor space, 16 x 7 ft.

Lathe, 13-In.

Selson Engineering Co., Ltd., London, E. C., England

"American Machinist" (European Edition), Sept. 4, 1920.

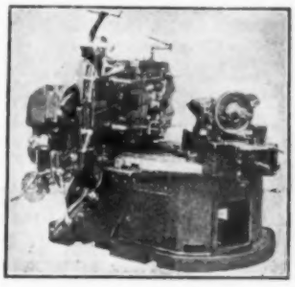


The swing over the bed of this lathe is 13¼ in. and in the gap 20 in. by 6½ in. from the faceplate, the swing over the carriage being 8 in. With a bed 6½ ft. long the maximum distance between centers is 3 ft. 3 in. The spindle is bored 1 5/16 in. to admit 1¼-in. bars. Three feeds and ten spindle speeds are provided, the latter ranging from 14 to 450 r.p.m. The tailstock sets over for taper-turning. A square turret carries tools of ¾-in. section. Weight, 1,650 lb.

Planer, Spiral Bevel Gear

Smith & Coventry, Ltd., Manchester, England

"American Machinist" (European Edition), Sept. 4, 1920.

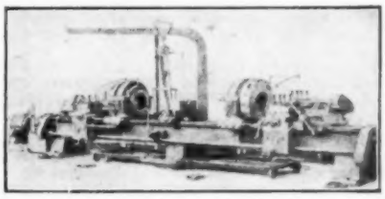


This machine has been designed to produce correct spiral bevel gears, the geometry of the spiral produced being of the same accuracy as the spiral spur gear or the involute curve used for the wheel tooth. The teeth produced are symmetrical at every section and the spiral of the teeth on the pitch cone is a correct geometrical figure having a uniform lead spiral. The "spiralty" is produced by imparting an angular movement to the wheel blank during the cutting operation.

Axle-Ending and Centering Machine

Tangyes, Ltd., Birmingham, England

"American Machinist" (European Edition), Sept. 4, 1920.

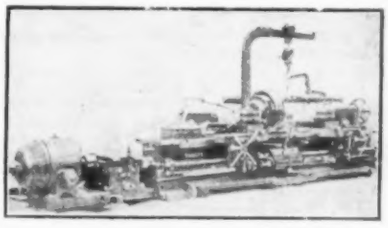


This machine turns end collars, faces to length and centers axles 4 ft. 9 in. to 9 ft. 6 in. long up to 9 in. in diameter. The headstocks have large spindles, each with a 10½-in. diameter hole. The main gear box is arranged for four speeds and is driven by a 15-hp. motor. The spindle speeds are 28 to 63 r.p.m. Each headstock engages the quick-power traverse screw, the speed being 5 ft. per minute. The centering spindle is driven at 360 r.p.m. by its independent 1½-hp. motor. The floor space is 24 ft. by 4 ft. 6 in.

Lathe, Axle-Turning, "Tangyes"

Alfred Herbert, Ltd., Coventry, England

"American Machinist" (European Edition), Sept. 4, 1920.

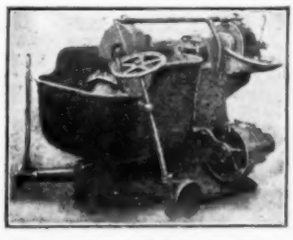


This lathe is designed for turning simultaneously both ends of a locomotive, carriage or wagon axle. The bed is 14 ft. by 25½ in. on top; lengths up to 8 ft. 6 in. can be taken between centers. The headstock has a large spindle with an 11-in. diameter hole. The four-speed gear box is coupled to a 15-hp. motor and a total of eight spindle speeds, from 12 to 80 r.p.m., can be obtained. The three feeds are 6, 12 and 22 revolutions per inch. A 9 x 9-in. turret carries four tools.

Grinding Machine, Tool, Curved-Lip

Lumsden Machine Co., Ltd., Gateshead, England

"American Machinist" (European Edition), Sept. 11, 1920.

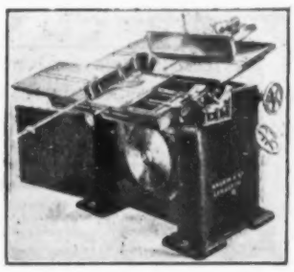


The curved-lip mechanism consists of a horizontal traversing slide mounted on a column having vertical adjustment. This slide is pivoted on the column and can be swung at any desired angle in the horizontal plane to the wheel. Mounted on the slide is a cross-slide carrying a swiveling vise, the base of which is mounted at an angle of about 40 deg. to the slide. All controls are hand operated. The end of the machine taking the 12-in. cup wheel carries a toolrest and wheel dresser.

Saw, Double Dimension, 16-in.

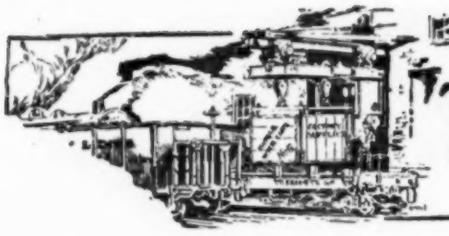
Wadkin & Co., Leicester, England.

"American Machinist" (European Edition), Sept. 11, 1920



This saw is suitable for such work as ripping, cross-cutting, beveling, tonguing, grooving, mitering, cutting compound angles, roughing-out coreboxes, etc. The entire table tilts by worm gearing up to 45 deg., the angle being indexed. The ripping fence has a front fence plate which cants from the vertical to 45 deg. and swivels 30 deg. either way. A cutting-off gage swivels right and left hand, the angles being shown on the sliding table surface. Miter gages are mounted on each side. Weight 1 ton.

Clip, paste on 3 x 5-in. cards and file as desired



THE WEEKLY PRICE GUIDE

IRON AND STEEL

PIG IRON—Quotations compiled by The Matthew Addy Co.:

CINCINNATI	Current	One Year Ago
No. 2 Southern	$44.50	$30.35
Northern Basic	40.00	27.55
Southern Ohio No. 2	42.00	28.55
NEW YORK—TIDEWATER DELIVERY		
2X Virginia (Silicon 2.25 to 2.75)	51.26	32.40
Southern No. 2 (Silicon 2.25 to 2.75)	48.26	35.20
BIRMINGHAM		
No. 2 Foundry	40.50	29.25
PHILADELPHIA		
Eastern Pa., No. 2x, 2.25–2.75 sil.	42.50	29.00–30.00
Virginia No. 2	46.25	33.10
Basic	38.25	26.75
Grey Forge	40.25	26.75
CHICAGO		
No. 2 Foundry local	40.00	26.75
No. 2 Foundry, Southern	46.66	28.00
PITTSBURGH, INCLUDING FREIGHT CHARGE FROM VALLEY		
No. 2 Foundry	41.96	28.15
Basic	38.00	27.15
Bessemer	38.00	29.35

* F.o.b. furnace. † Delivered.

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3.80	$4.15	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	3.70	4.15	3.37	3.34	3.27	3.48	3.37
Soft steel bar shapes	3.70	4.15	3.37	3.48	3.27	3.48	3.37
Soft steel bands	4.65	5.50	4.07	6.25	.....	.....	.....
Plates, ¼ to 1 in. thick	4.00	4.15	3.67	3.78	3.57	3.78	3.67

BAR IRON—Prices per 100 lb. at the places named are as follows:

	Current	One Year Ago
Mill, Pittsburgh	$4.25	$2.77
Warehouse, New York	4.75	3.37
Warehouse, Cleveland	3.52	3.27
Warehouse, Chicago	4.12	3.37

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

Blue Annealed	Large Mill Lots Pittsburgh	New York Current	New York One Year Ago	Cleveland	Chicago
No. 10	3.55–4.50	5.20@6.15	4.57	5.00	6.13
No. 12	3.60–4.55	5.25@6.20	4.62	5.05	6.18
No. 14	3.65–4.60	5.30@6.25	4.67	5.10	6.23
No. 16	3.75–4.70	5.40@6.35	4.77	5.20	6.33
Black					
Nos. 18 and 20	4.20–5.35	6.50@8.00	5.30	5.60	6.90
Nos. 22 and 24	4.25–5.40	6.55@8.05	5.35	5.75	6.95
No. 26	4.30–5.45	6.60@8.10	5.40	5.80	7.00
No. 28	4.35–5.50	6.70@8.20	5.50	5.90	7.10
Galvanized					
No. 10	4.70–6.00	8.00@8.25	5.75	6.25	7.25
No. 12	4.80–6.10	8.10@8.25	5.85	6.35	7.30
No. 14	4.80–6.10	8.10@8.35	5.85	6.35	7.45
Nos. 18 and 20	5.10–6.40	8.35@8.65	6.15	6.65	7.75
Nos. 22 and 24	5.25–6.55	8.50@8.80	6.30	6.80	8.15
No. 26	5.40–6.70	8.65@8.95	6.45	6.95	8.30
No. 28	5.70–7.00	8.95@9.25	6.75	7.25	8.60

Acute scarcity in sheets, particularly black, galvanized and No. 16 blue enameled. Automobile sheets are unavailable except in fugitive instances, when prices are 9.45c per lb. for No. 16; 9.50 for Nos. 18 and 20, and 9.55c for Nos. 22 and 24.

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$5.50	$5.80	$4.84
Flats, square and hexagons, per 100 lb. base	6.00	6.30	5.34

DRILL ROD—Discounts from list price are as follows at the places named:

	Per Cent.
New York	50
Cleveland	50
Chicago	50

NICKEL AND MONEL METAL — Base prices in cents per pound F.O.B. Bayonne, N. J.

Nickel	
Ingot and shot	43
Electrolytic	45

Monel Metal			
Shot and blocks	35	Hot rolled rods (base)	42
Ingots	38	Cold rolled rods (base)	56
Sheet bars	40	Hot rolled sheets (base)	55
Special Nickel and Alloys			
Malleable nickel ingots			45
Malleable nickel sheet bars			47
Hot rolled rods, Grades "A" and "C" (base)			60
Cold drawn rods, grades "A" and "C" (base)			72
Copper nickel ingots			42
Hot rolled copper nickel rods (base)			52
Manganese nickel hot rolled (base) rods "D" — low manganese			64
Manganese nickel hot rolled (base) rods "D"— high manganese			67

Domestic Welding Material (Swedish Analysis)—Welding wire in 100-lb lots sells as follows, f. o. b. New York: ⅛, 8½c. per lb.; ¼, 8c.; ⅜ to ½, 7½c Domestic iron sells at 12c. per lb.

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Openhearth spring steel (heavy)	7.00	8.00	9.00
Spring steel (light)	10.00	7.00	12.00
Coppered bessemer rods	9.00	8.00	6.75
Hoop steel	4.70	4.04	5.32
Cold-rolled strip steel	12.50	8.25	10.75
Floor plates	6.25	4.00	6.63

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galvanized	Inches	Iron Black	Iron Galvanized
¼ to 3	54–57½%	41½–44%	⅛	15½–25½%	+1½–11½%
			¼	19½–29½%	1½–11½%
			⅜ to 1¼	24½–34½%	8 –18½%

LAP WELD

2	47 –50½%	34½–38%	1¼	.....	.....
2½ to 6	50 –53½%	37½–41%	1½	.....	.....
7 to 12	47 –50½%	33½–37%	2	20½–28½%	6½–14½%
13 to 14	37½–41 %	.....	2½ to 6	22½–30½%	9½–17½%
15	35 –38½%	.....	7 to 12	22½–30½%	9½–17½%
				19½–27½%	6½–14½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

¼ to 1¼	52 –55½%	39½–43%	⅜ to 1¼	24½–34½%	9½–19½%
2 to 3	53 –56½%	40½–44%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	45 –48½%	33½–37%	1¼	.....	.....
2½ to 4	48 –51½%	36½–40%	1½	.....	.....
4½ to 6	47 –50½%	35½–39%	2	21½–29½%	8½–16½%
7 to 8	43 –46½%	29½–33%	2½ to 4	23½–31½%	11½–19½%
9 to 12	38 –41½%	24½–28%	4½ to 6	22½–30½%	10½–18½%
			7 to 8	14½–22½%	2½–10½%
			9 to 12	9½–17½%	5½–+2½%

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv.
⅜ to 3 in. steel butt welded	38%	22%	39%	30%	54%40%	40½@30 %
2½ to 6 in. steel lap welded	33%	18%	41%	26%	50@40%	37½@27½%

Malleable fittings. Classes B and C, banded, from New York stock sell at plus 45%. Cast iron, standard sizes, plus 5%.

METALS

MISCELLANEOUS METALS—Present and past New York jobbers' quotations in cents per pound, in quantities up to car lots:

	Current	Month Ago	Year Ago
Copper, electrolytic	15.00	15.50	22.50
Tin in 5-ton lots	36.25	38.75	56.50
Lead	5.75	6.75	6.25
Zinc	7.00	7.00	7.60
ST. LOUIS			
Lead	6.25	7.25	6.00
Zinc	6.75	6.25	7.15

At the places named, the following prices in cents per pound prevail, for 1 ton or more:

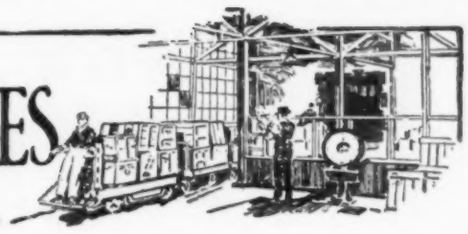
	New York Current	New York Month Ago	New York Year Ago	Cleveland Current	Cleveland Year Ago	Chicago Current	Chicago Year Ago
Copper sheets, base	22.50	23.50	33.50	24.50	35.50	28.50	36.50
Copper wire (carload lots)	20.00	20.00	30.75	22.00	30.50	25.00	26.00
Brass sheets	22.25	28.50	32.00	25.00	33.00	25.25	28.00
Brass pipe	25.00	28.00	36.00	27.00	39.00	30.00	37.00
Solder (half and half) (case lots)	27.75	29.00	45.00	29.00	41.00	22.50	38.50

Copper sheets quoted above hot rolled 24 oz., cold rolled 14 oz. and heavier, add 2c.; polished takes 5c. per sq.ft. extra for 20-in. widths and under; over 20 in., 7½c.

BRASS RODS—The following quotations are for large lots, mill. 500 lb. and over, warehouse; net extra:

	Current	One Year Ago
Mill	18.25	24.00
New York	19.50	28.00@29.75
Cleveland	23.00	29.00
Chicago	23.25	27.00

SHOP MATERIALS AND SUPPLIES



ZINC SHEETS—The following prices in cents per pound are f.o.b. mill + less 8% for carload lots 11.50

	Warehouse			
	—In Casks—		— Broken Lots —	
	Current	One Year Ago	Current	One Year Ago
Cleveland	15.30	12.50	14.70	13.00
New York	14.00	11.50	14.50	12.50
Chicago	14.50	16.50	14.95	16.00

ANTIMONY—Chinese and Japanese brands in cents per pound, in ton lots for spot delivery, duty paid:

	Current	One Year Ago
New York	6.50	9.50
Chicago	7.00	9.75
Cleveland	7.50	9.75

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	*New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy, and crucible	12.00	17.00	10.00	11.50
Copper, heavy, and wire	11.50	16.00	9.50	11.00
Copper, light, and bottoms	10.00	14.00	9.00	9.50
Lead, heavy	4.00	4.75	4.00	4.50
Lead, tea	3.00	3.75	3.00	3.50
Brass, heavy	7.00	10.50	7.00	10.50
Brass, light	5.50	7.50	5.00	5.50
No. 1 yellow brass turnings	6.50	10.00	5.50	5.50
Zinc	4.50	5.00	3.00	4.50

*These prices nominal because of dull market

ALUMINUM—The following prices are from warehouse at places named:

	New York	Cleveland	Chicago
No. 1 aluminum, 98 to 99% pure, in ingots for remelting (1-15 ton lots), per lb	$33.00	$26.00	$33.50

COPPER BARS—From warehouse sell as follows in cents per pound, for ton lots and over:

	Current	One Year Ago
New York (round)	28.00	32.00
Chicago	21.00	31.00
Cleveland	25.00	35.00

BABBITT METAL—Warehouse price per pound:

	—New York—		—Cleveland—		— Chicago —	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	70.00	90.00	46.00	70.00	43.00	60.00
Commercial	30.00	50.00	16.50	16.50	11.00	13.00

NOTE—Price of babbitt metal is governed largely by formula, no two manufacturers quoting the same prices. For example, in New York we quote the best two grades, although lower grades may be obtained at from $16 to $20.

SHOP SUPPLIES

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	—New York—		— Cleveland —		— Chicago —	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Hot pressed square	+$1.25	$1.50	List net	$2.25	+1.15	1.85
Hot pressed hexagon	+ 1.25	1.50	List net	2.25	+1.15	1.85
Cold punched hexagon	+ 1.25	1.50	List net	2.25	+1.15	1.30
Cold punched square	+ 1.25	1.50	List net	2.25	+1.15	1.30

Semi-finished nuts, ⅞ and smaller, sell at the following discounts from list price:

	Current	One Year Ago
New York	30%	50–10%
Chicago	40%	50%
Cleveland	50%	55%

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago
½ by 4 in. and smaller	+10%	30%	20%
Larger and longer up to 1¼ in. by 30 in.	Net list	30%	10%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

For wrought-iron washers:
New York ..... list Cleveland ..... $2.50 Chicago $1.90

For cast-iron washers, ¼ and larger, the base price per 100 lb. is as follows:
New York ..... $7.00 Cleveland ..... $4.50 Chicago $5.50

CARRIAGE BOLTS—From warehouses at the places named the following discounts from list are in effect:

	New York	Cleveland	Chicago
½ by 6 in. and smaller	+20%	30%	20%
Larger and longer up to 1 in. by 30 in.	+20%	25%	15%

COPPER RIVETS AND BURS sell at the following rate from warehouse:

	Rivets		Burs	
	Current	One Year Ago	Current	One Year Ago
Cleveland	25%	20%	10%	10%
Chicago	net	20%	net	20%
New York	30%	40%	net	20%

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	20%	40–5%	30%
Tinned	20%	40–5%	30%

Boiler, ¾, ⅞, 1 in. diameter by 2 to 5 in. sell as follows per 100 lb.:
New York ..... $6.00 Chicago ..... $5.73 Pittsburgh $4.50

Structural, same sizes:
New York ..... $5.73 Chicago ..... $5.83 Pittsburgh $4.60

MISCELLANEOUS

SEAMLESS DRAWN TUBING—The base price in cents per pound from warehouse in 100-lb. lots is as follows:

	New York	Cleveland	Chicago
Copper	$26.00	30.00	31.00
Brass	25.00	27.00	30.00

The prices, of course, vary with the quantity purchased. For lots of less than 100 lb., but not less than 75 lb., the advance is 1 c.; for lots of less than 75 lb., but not less than 50 lb., 2½c. over base (100-lb. lots); less than 50 lb., but not less than 25 lb., 5c. should be added to base price; quantities from 10-25 lb., extra is 10c.; less than 10 lb., add .15–20c.

Double above extras will be charged for angles, channels and sheet metal mouldings if ordered in above quantities. Above extras also apply to brass rod other than standard stock sizes—stock sizes being considered as ⅛-2 in. inclusive in rounds, and ⅛-1½ in., inclusive, in square and hexagon—all varying by thirty seconds up to 1 in. by sixteenths over 1 in. On shipments aggregating less than 100 lb., there is usually a boxing charge of $1.50.

LONG TERNE PLATE—In Chicago No. 28 primes from stock sell, nominally, for $8.85 per 100 lbs.

In Cleveland—$10 per 100 lbs.

COTTON WASTE—The following prices are in cents per pound:

	— New York —			
	Current	One Year Ago	Cleveland	Chicago
White	15.00@17.00	13.00	15.00	15.00@17.00
Colored mixed	9.00@14.00	9.00–12.00	11.00	11.00@13.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½x13½	13½x20½
Cleveland	55.00	65.00
Chicago	41.00	43.50

SAL SODA sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$2.00	$2.00	$1.75
Philadelphia	2.75	2.75	1.75
Cleveland	3.00	3.00	2.50
Chicago	2.00	2.75	2.00

ROLL SULPHUR in 360-lb. bbl. sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$3.50	$3.90	$3.65
Philadelphia	3.65	3.65	3.87
Chicago	3.85	5.00	4.12½

COKE—The following are prices per net ton at ovens, Connellsville:

	December 13	December 6	November 29
Prompt furnace	$ 8.00@$10.00	$8.00@$10.50	$11.50@$12.00
Prompt foundry	10.00@ 12.00	10.00@ 12.00	12.50@ 13.00

FIRE CLAY—The following prices prevail:

		Current
Ottawa, bulk in carloads	Per Ton	$8.00
Cleveland	100-lb. bag	1.00

LINSEED OIL—These prices are per gallon:

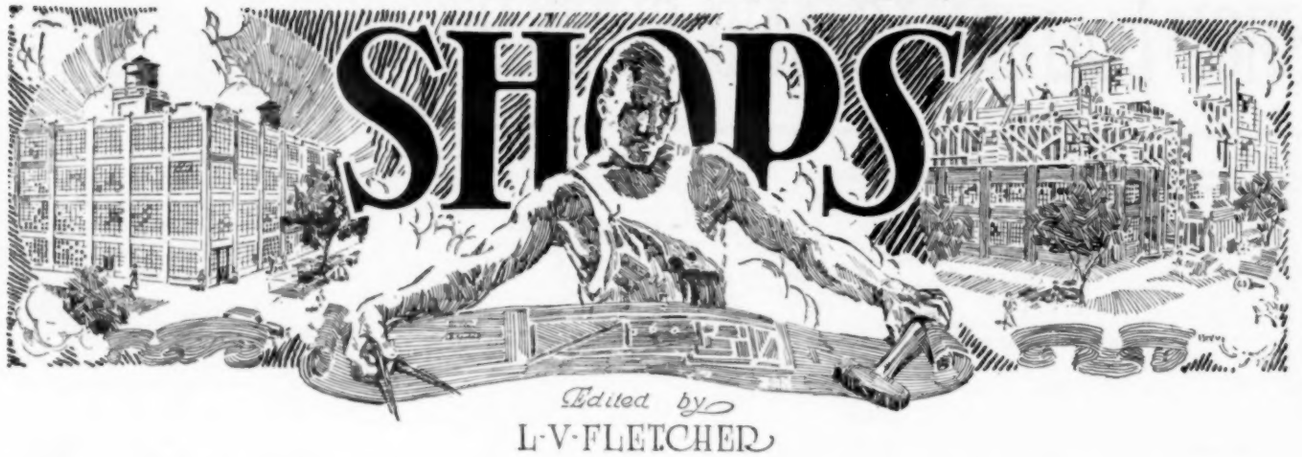
	—New York—		—Cleveland—		—Chicago—	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw in barrels, (5 bbl. lots)	$0.90	$2.15	$1.05	$2.50	$0.97	$2.37
5-gal cans	1.05	2.30	1.30	2.75	1.22	2.57
1-gal cans (6 to case)	1.15	....	....	....	....	....

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		One Year Ago		Current	One Year Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100 lb. keg	14.25	15.75	13.00	14.50	14.25	13.00
25 and 50-lb. kegs	14.50	16.00	13.25	14.75	14.50	13.25
12½-lb. keg	14.75	16.25	13.50	15.00	14.75	13.50
5-lb. cans	17.25	18.75	15.00	16.50	17.25	15.00
1-lb. cans	19.25	20.75	16.00	17.50	19.25	16.00

500 lb. lots less 1% discount. 2000 lb. lots less 10–20½% discount.

NEW and ENLARGED



Edited by
L·V·FLETCHER

Machine Tools Wanted

If in need of machine tools send us a list for publication in this column

Conn., Hartford — The Hartford Machine Screw Co., 476 Capitol Ave.—miscellaneous machine tools.

Mass., South Boston—The T. L. Harkins Machine Co., 50 Farnsworth St.—machine tool equipment.

Tenn., Nashville—R. R. Sanders, 508 Gay St., manufacturer of jewelry and novelties—No. 91 Bliss double crank press, (used).

Va., Richmond—The Virginia Machinery and Well Co., 1319 East Main St., C. F. Cole, Pres. and Treas.—one 4½ in. to 6 in. or 4½ in. to 8 in. portable pipe threading machine.

W. Va., Logan — The Guyan Machine Shops, B. Shell, Purch. Agt.—general machine shop equipment including shaper, punch, shear and drill.

Ill., Chicago — The Natl. Plumbing & Heating Co., 6044 South State St.—pipe manufacturing equipment.

Ill., Chicago—H. G. Paro Co., 1412 South Michigan Ave.—one 14 or 16 in. lathe with chucks and a 1 in. bolt threader.

Ill., Chicago—The Rock Island R.R., La Salle St., F. D. Reed, Purch. Agt.—1 improved style 5 A pipe bending machine.

Ill., Chicago—The Union Ry. Equipment Co., McCormick Bldg.—one 4 spindle heavy duty drill, (used).

Mich., Birmingham — H. W. Booth—machines and tools for sheet metal-working shop.

Mich., Detroit—D. Cotwell, Hamilton Ave. and Methune St.—mechanical equipment for garage.

O., Columbus—The L. & S. Mfg. Co., 2625 North High St., manufacturers of metal specialties and auto accessories, L. C. Lewis, Genl. Mgr.—complete metal working machinery to include lathe, drill press, grinder, etc.

Wis., Milwaukee — The Universal Appliance Co., 625 Cedar St., A. A. Kern, Purch. Agt.—machine tools for the manufacture of automobile appliances.

Wis., Milwaukee—The Wetzel Art Furniture Co., 1367 Green Bay Ave. — drum sander, jig saw, trim saw, etc., for Cedarburg plant.

Wis., Oshkosh—The Giant Grip Mfg. Co., 29 Osceola St., manufacturers of horseshoes—one trimming press.

Wis., Waupaca—Waupaca County, C. J. Knudson, Court House, Purch. Agt.—machinery for repairing of highway machinery.

Wis., West Allis—The Warner Machine Co., 7521 Scott St.—heavy duty grinder for car wheel work.

Minn., Mankato—The Little Giant Co.—3 lathes similar to Oliver Machinery Co.'s No. 56—motor drive, (new or used).

Mo., St. Louis—T. J. Moss Tie Co., Security Bldg.—pipe threading machines for its branch at Granville, Wis.

Que., Montreal—The Can Welding Co., Amherst St. near Ontario St.—equipment for its proposed plant on St. Timothee St.

Que., Rimouski—J. A. Theberge—equipment for garage repair work.

Machinery Wanted

N. J., Asbury Park—The New Jersey Cleaning & Dyeing Co., 505 Main St.—machinery.

N. Y., New York—(Borough of Bronx) Niewenhous Bros., 165th St. and Park Ave. —1 gasoline driven portable saw.

Pa., Williamsport—The Vallamont Building & Planing Mill Co.—machinery.

Mich., Marquette—The Paveglio Granite & Marble Co., P. Paveglio, Purch. Agt.—traveling crane.

O., Columbus—J. W. Goddard, 776 East Starr Ave.—barrel stave machinery.

O., Toledo—The U. S. Mop Co.—one No. 3 punch press.

Wis., Green Bay—Brown County, J. J. Cormier, Courthouse, Purch. Agt. — one loading crane.

Wis., Kaukauna—The Molock Co., manufacturers of stokers—4 electric traveling cranes.

Wis., Milwaukee—The Atlas Bread Co., 927 Central Ave.—bakery equipment.

Wis., Milwaukee—The Badger Concrete Mixer Co., 221 Grand Ave.—crane for its plant at Watertown.

Wis., Shawano—C. Foesch, cabinet maker —wood-working machinery.

Tex., Dallas—The Bd. Educ., Municipal Bldg.—shop equipment for manual training department.

Ont., Kingsville—The Conklin Planing Mills—equipment.

Ont., Wallaceburg — The Wallaceburg Glass Co., Ltd.—equipment.

Metal Working

NEW ENGLAND

Conn., Hartford—T. R. Forestiere, c/o B. L. Sellew, Archt., 223 Aylum St., is having preliminary plans prepared for the construction of a 2 story, 12 x 50 ft. addition to his garage and bottling plant, on Charter Oak Pl.

Conn., New Haven—A. C. Gilbert Co., Blatchley Ave., has awarded the contract for the construction of a 1 story, 26 x 240 ft. addition to its toy plant. Estimated cost, $7,500.

Mass., Allston (Boston P. O.)—The T. L. Harkins Machine Co., 50 Farnsworth St., South Boston, has had plans prepared for the construction of a 2 story, 50 x 100 ft. plant on Union Sq., for the manufacture of vulcanizing machinery.

Mass., Cambridge—G. Lawrence, Inc., 24 Cambria St., will soon award the contract for the construction of a 1 story addition to its plant, for the manufacture of automobile springs. Estimated cost, $40,000. W. T. Littlefield, 9 Hamilton Pl., Boston, Archt. Noted Aug. 5.

Mass., South Boston (Boston P. O.)—The State Bd. of Pub. Wks., State House, Boston, has awarded the contract for the construction of a 1 story, 60 x 325 ft. portable steel garage, here. Estimated cost, $20,000.

N. H., Manchester—The United States Bobbin & Shuttle Co., Main St., has awarded the contract for the construction of a 2 story addition to its manufacturing plant. Estimated cost, $25,000.

MIDDLE ATLANTIC STATES

D. C., Georgetown—The Rosslyn Steel & Cement Co., Woodward Bldg., will soon award the contract for altering and constructing a 100 x 200 ft. addition to its shop.

Md., Baltimore—Gibson & Kirk Co., 211 Key Highway, has had plans prepared for the construction of a 1 story, 30 x 91 ft. foundry, for the manufacture of brass marine hardware.

Md., Baltimore — Ralinek & Brambart, Pennington Ave. and Beech St., have had plans prepared for the construction of a 16 x 39 ft. foundry.

Md., Baltimore—G. R. Vincenti, 312 Light St., is having plans prepared for the construction of a 3 story, 127 x 140 ft. garage at 3-7 North Paca St. Estimated cost, $60,000. E. G. Blanke, 532 North Calvert St., Archt.

Md., Curtis Bay (Baltimore P. O.)—The Baltimore Car & Fdry Co., Curtis Ave. and Locust St., has had plans prepared for the construction of two 1 story additions to its plant. Estimated cost, $18,000.

N. J., Camden—J. B. Van Sciver Co., Market St. Ferry, manufacturers of furniture, carpets, etc., has awarded the contract for the construction of a 1 story, 30 x 70 ft. kiln building.

N. J., Newark—The Jay Realty Co., 790 Broad St., has awarded the contract for the construction of a 1 story, 50 x 100 ft. garage on Jay and Dickerson Sts. Estimated cost, $14,800.

N. J., Newark — The Southern Lumber Co., 870 Broad St., has awarded the contract for the construction of a 1 story, 45 x 80 ft. garage at 427 Halsey St. D. Jacobson, Genl. Mgr.

N. J., Trenton — The Remington Phonograph Co., 1662 Bway., New York City, has purchased a 14.83 acre site, here, and plans to construct a large phonograph and record factory.

N. J., Trenton—The Star Motor Sales Corp. has awarded the contract for the construction of a 2 story, 65 x 70 ft. repair shop and storage plant on Prince St. Estimated cost, $10,000.

N. Y., Binghamton—The Auto Storing Co., Chamber of Commerce Bldg., is having plans prepared for the construction of a 2 story garage on Henry St. Estimated cost, $175,000. A. T. Lacey, Kilmer Bldg., Archt.

N. Y., Buffalo—The Hewitt Rubber Co., 240 Kensington Ave., has awarded the contract for the construction of a 1 story, 30 x 180 ft. addition to its factory. Estimated cost, $30,000.

N. Y., Jamaica—G. Cooke, Kissam Pl., will soon award the contract for the construction of a 1 story, 35 x 60 ft. machine shop on the corner of Kissam Pl. and Archer Pl. Estimated cost, $9,500. H. T. Jeffrey, Jr., 309 Fulton St., Archt.

N. Y., Jamaica—A. Hoerning, c/o F. J. Schfeick, Archt., 4168 Park Ave., New York City, will build a 1 story, 100 x 155 ft. garage on Hillside Ave. Estimated cost, $30,000.

N. Y., New York (Borough of Bronx)—A. C. Chesley & Co., 277 Rider Ave., manufacturers of fireproof doors, is having plans prepared for the construction of a 2 story, 50 x 200 ft. factory, on 132d st. and Cypress Ave. Estimated cost, $100,000. P. J. Murray, 141 East 40th St., New York City, Archt. and Engr.

N. Y., New York (Borough of Bronx)—The Ferncliffer Garage, Inc., c/o DeRose & Cavalieri, Archts. and Engrs., 370 East 149th St., will build a 1 story, 120 x 125 ft. garage on 3d Ave. near Franklin Ave. Estimated cost, $75,000.

N. Y., New York (Borough of Bronx)—T. Phelan, c/o Moore & Landseidel, Archts. and Engrs., 148th St. and 3d Ave., will build a 1 story garage on Burnside Ave. Estimated cost, $50,000.

N. Y., New York (Borough of Brooklyn)—D. Eisenberg, c/o F. Millman & Son, Archts., 26 Court St., will build a 1 story, 80 x 100 ft. garage on De Kalb Ave. near Skillman St. Estimated cost, $25,000.

N. Y., New York (Borough of Brooklyn)—The Garage Property Corp., 44 Court St., will build a 1 story, 90 x 100 ft. garage on Lawrence Ave. Estimated cost, $30,000. T. H. Gluck, Pres.

N. Y., New York (Borough of Brooklyn)—S. Morrison, 99 Clarkson St., has awarded the contract for the construction of a 1 story, 20 x 52 ft. garage and repair shop. Estimated cost, $10,000.

N. Y., New York (Borough of Brooklyn)—The Victory Operating Co., c/o S. Millman, Archt., 26 Court St., will build a 1 story, 115 x 140 ft. garage on Parkside Ave. between Rogers and Nostrand Aves. Estimated cost, $45,000. S. Halperin, Pres.

N. Y., New York (Borough of Manhattan)—The Dorsma Garage Corp., c/o F. J. Schefeick, Archt., 4168 Park Ave., will alter 1 story garage and build a 1 story, 55 x 115 ft. addition to same at 1016 St. Nicholas Ave. Estimated cost, $45,000.

N. Y., New York (Borough of Manhattan)—F. Hogan, 45 East 135th St., has awarded the contract for the construction of a 1 story, 25 x 99 ft. garage at 52 West 140th St. Estimated cost, $10,000.

N. Y., New York (Borough of Manhattan)—The Hup Realty Co., 229 East 38th St., has awarded the contract for the construction of a 1 story, 75 x 100 ft. garage at 317 East 38th St. Estimated cost, $30,000.

Pa., Bethayres—Klauder-Weldon of Jenkintown are having plans prepared for the construction of a 1 story, 150 x 250 ft. factory for the manufacture of dyeing machinery. C. B. Keen Bailey Bldg., Philadelphia, Archt.

Pa., Philadelphia—Stokes & Smith, Summerdale Station, manufacturers of box machinery, have awarded the contract for altering their 2 story factory at Summerdale Station along the tracks of the Philadelphia & Reading R. R. Estimated cost, $19,000.

Pa., Philadelphia—M. Wenger, 1229 Walnut St., has awarded the contract for altering and constructing an addition to his garage. Estimated cost, $15,000.

Pa., Sheridan—The Acme Die & Stamping Co., McKees Rocks, will soon award the contract for the construction of a 2 story, 40 x 96 ft. factory, here. Estimated cost, $50,000. J. H. Phillips, Fulton Bldg., Pittsburgh, Archt.

MIDDLE WEST STATES

Ill., Chicago—The Railway Steel Spring Co., 30 Church St., New York City, has awarded the contract for the construction of an addition to its factory on Chicago Heights, here. Estimated cost, $60,000.

Mich., Detroit—D. Cotwell, Hamilton Ave. and Bethune St., plans to build a 2 story, 50 x 170 ft. addition to his garage. Estimated cost, $50,000. William Bros., 1111 Kresge Bldg., Archts.

Mich., Detroit—The Detroit Evening News Co., Lafayette Blvd., has awarded the contract for the construction of a 1 story, 90 x 140 ft. garage. Estimated cost, $75,000. Noted Oct. 21.

O., Cleveland—The Cataract Motor Sales Co., 8812 Bway., has awarded the contract for the construction of a 3 story, 77 x 250 ft. garage at 8807 Bway. Estimated cost, $150,000.

O., Cleveland—The Prame Realty Co., c/o J. H. Dickman, 214 Williamson Bldg., is having plans prepared for the construction of a 1 story garage at 742 Hamilton Ave. Estimated cost, $50,000. W. S. Lougee, Marshall Bldg., Archt.

O., Cleveland—M. Purer, 2724 East 53rd St., will soon award the contract for the construction of a 1 story, 80 x 120 ft. garage at 796 East 105th St. Estimated cost, $40,000. M. Orlin, 2909 East 112th St., Archt.

O., Cleveland—The Realty Syndicate Co., c/o F. Riley, 309 Williamson Bldg., will soon award the contract for the construction of a 4 story, 116 x 240 ft. commercial building and garage on East 79th St. and Hough Ave. Estimated cost, $300,000. J. M. Dyer, Ulmer Bldg., Archt.

O., Cleveland—The Republic Tool & Mfg Co., 1399 West 9th St., is having plans prepared for the construction of a 2 story factory and warehouse on Harvard Ave. and East 49th St. Estimated cost, $200,000. G. S. Rider & Co., 1900 Euclid Ave., Archts.

O., Cleveland—J Spang Baking Co., 2701 Barber Ave., has awarded the contract for the construction of a 1 story, 25 x 62 ft. garage at 2603 West 30th St. Estimated cost, $10,000. Noted Oct. 28.

O., Cleveland—W. S. Tyler Co., East 36th St. and Superior Ave., has awarded the contract for the construction of a 4 story, 60 x 260 ft. factory for the manufacture of ornamental iron. Estimated cost, $200,000. Noted Dec. 2.

O., Cleveland—G. Zauba, 1848 West 24th St., will build a 1 story, 27 x 80 ft. garage. Estimated cost, $10,000.

O., Columbus—The Brown Steel Co., 480 Neilston St., is having plans prepared for the construction of a 1 story, 55 x 390 ft. shop on Marion Rd. Estimated cost, $75,000.

O., Columbus—The Ohio Highway Comn., Stoneman Bldg., has had plans prepared for the construction of a 1 story, 100 x 150 ft. garage and number of sheds. Estimated cost, $175,000. V. Redding, 30 Bird Bldg., Mansfield, Archt.

O., Yorkville—The Wheeling Steel & Iron Co. plans to build an addition to its tin mill here. Estimated cost, $150,000.

Wis., Milwaukee—The city is having plans prepared for the construction of a 1 story, 18 x 30 ft. blacksmith shop at 6th St. Viaduct. Estimated cost, $5,000. C. E. Malig, City Hall, Archt.

Wis., Sheboygan Falls—P. Kwekkelboon, 10th Ave., is having plans prepared for the construction of a 2 and 3 story, 65 x 120 ft. garage, sales room and office building. M. Howard, Sheboygan Falls, Archt.

Wis., Valders—W. E. Christel is having preliminary plans prepared for the construction of a 2 story, 50 x 85 ft. garage and office building on Main St. Estimated cost, $75,000. Juul-Smith, Imig Bldg., Sheboygan, Archts

WEST OF THE MISSISSIPPI

Ia., Cedar Rapids—The Chicago, Rock Island & Pacific R.R. Co., 179 West Jackson Blvd., Chicago, plans to build a 1 story, 40 x 60 ft. wheel repair shop and improve its shops here. Estimated cost, $16,000.

Ia., Vinton—The Vinton Truck & Mfg. Co. plans to build a plant. W. F. Mether and J. McElroy of Vinton are interested.

Minn., St. Paul—E. Swanson, 129 La Fond St., is having plans prepared for the construction of a 1 story, 112 x 140 ft. garage on Selby Ave. and Dunlap St. Estimated cost, $45,000. W. D. MacLeith, 432 Endicott Bldg., Archt.

WESTERN STATES

Wash., Tacoma—The City Council has passed an ordinance authorizing the construction of a storehouse and shops for the water and light department. Estimated cost, $80,000. I. S. Davidson, Comr. of Light and Water.

CANADA

B. C., Vancouver—The Coast Range Steel Co., 419 Metropolitan Bldg., recently incorporated with $15,000,000 capital stock, plans to build a large iron and steel works, near here.

Ont., Ottawa—The Dept of Pub. Wks. has awarded the contract for the construction of an ore dressing plant. Estimated cost, $6,233.

Ont., Owen Sound—The Corbet Fdry & Machine Co., 1064 1st Ave., W., plans to build a 2 story, 60 x 90 ft. addition to its foundry and machine shop. Estimated cost, $25,000. Forrester & Clark, 1076 1st Ave., W., Archts.

Que., Rimouski—J. A. Theberge plans to build a garage to accommodate 20 cars.

General Manufacturing

NEW ENGLAND STATES

Conn., New Haven—The Connecticut Sash & Door Co., 451 Grand Ave., plans to construct 3 buildings on Grand Ave., to replace those which were recently destroyed by fire. Loss, $70,000. Private plans.

Mass., South Egremont—The Bershire Stone Products Corp. of Boston has awarded the contract for the construction of 3 lime kilns, stone crushing plant, saw sheds, 60 x 400 ft. crane and runway and various other frame buildings, etc. at its plant, here. Estimated cost, $100,000.

N. H., Seabrook—Seabrook associates has awarded the contract for the construction of a 1 story, 45 x 250 ft. factory, for the manufacture of shoes. Estimated cost, $20,000.

MIDDLE ATLANTIC STATES

N. J., Asbury Park—The New Jersey Cleaning & Dyeing Co., 505 Main St., plans to build a 2 story, 50 x 92 ft. dyeing plant Estimated cost, $30,000.

N. J., New Brunswick—The State Building Comn., Trenton, is having plans prepared for the construction of a 2 story, 50 x 80 ft. ceramic building. Estimated cost, $100,000. F. H. Bent, 142 West State St., Trenton, Archt

Pa., Philadelphia—Kolbs Bakery, 10th and Reed Sts., has awarded the contract for altering and constructing an addition to its bakery on Broad and Butler Sts. Estimated cost, $100,000.

Pa., Williamsport—The Vallamont Building & Planing Mill Co. plans to construct a 6 story, 100 x 200 ft. planing mill and warehouse, on Pine and Court Sts. The first floor will be used as mill and the upper floors as warehouse and supply house Estimated cost, $100,000.

SOUTHERN STATES

Fla., Palatka—Stringfellow, Padgett & Co. has had plans prepared for the construction of a cold storage plant. A. Haile, Mgr. Private plans.

La., Kaplan—The town will issue $40,000 bonds to construct an ice plant. E. Miers, Genl. Mgr.

La., New Orleans—The Apex Paper Co., Paris Ave. and the New Orleans Terminal R.R., manufacturers of toilet paper, will build a 1 story, 40 x 90 ft. warehouse and factory Estimated cost, $50,000. H. W. Schlosser, Secy.

La., New Orleans—The International Harvester Co., 606 South Michigan Ave., Chicago, has had preliminary plans prepared for the construction of a twine manufacturing plant, and a storage warehouse for farm implements manufactured in the Central Mississippi Valley. The industry will occupy a front of 700 ft. on the river on the Jefferson side, between Napoleon Ave. and Louisiana Ave. ferries, here. Estimated cost, $6,000,000. Private plans.

N. C., Gastonia—Arkray Mills has awarded the contract for the construction of a 20,000 spindle cotton mill. Estimated cost, $750,000.

N. C., Greensboro—The Allright Mfg. Co. plans to construct a 2 story, 110 x 130 ft. building to cover 46,000, sq.ft. of floor space, also a dry kiln, shed, etc., for the manufacture of toilet seats. T. W. Alderman, Secy.

S. C., Dillon—The McLellan Cotton Gin Co. plans to rebuild its ginery which was recently destroyed by fire. Estimated loss, $65,000.

Tenn., Chattanooga—The Chattanooga Stamping and Enameling Co. has awarded the contract for the construction of an addition to its plant. Estimated cost, including equipment, $20,000.

Va., Norfolk—The Cementile Roofing Corp., 19th St. and Monticello Ave., has awarded the contract for the construction of a mill building for the manufacture of roofing tile. A. LeB. Ribble, Mgr.

W. Va., Huntington—The Wilson Creamery Co. is having plans prepared for the construction of a 2½ story, 75 x 140 ft. ice cream plant. Estimated cost, $125,000. McCormick Co., Century Bldg., Pittsburgh, Pa., Archts. and Engrs.

MIDDLE WEST

Ill., Centralia—The Amer Rubber Co., 1526 Wabash St., Chicago, will soon award the contract for the construction of a 2 story, 60 x 400 ft. rubber factory. Estimated cost, $100,000. The Consulting Co., 2801 Union Central Bldg., Cincinnati, O., Archts.

Ill., Elgin—The Sweet Spot Confectionery Co. has awarded the contract for the construction of a 2 story, 70 x 80 ft. ice cream manufacturing plant. Estimated cost, $40,000.

Ind., Kendallville—The Noble Tire & Rubber Co. will receive bids after Jan. 1, for the construction of a 2 story, 50 x 200 ft. rubber factory. Estimated cost, $75,000. A. M. Strauss, 207 Bank Bldg., Ft. Wayne, Archt.

Mich., Flint—The Perkins Structural Steel Co., 1603 Garland St., is building a 60 x 200 ft. steel fabricating plant. Estimated cost, $40,000. W. L. Perkins, Treas. and Mgr.

Mich., Port Huron—C. Kern & Co. plans to build a 2 story ice plant on River St. Estimated cost, $100,000. Private plans.

O., Cleveland—The Cleveland Refrigerator Co., 2996 East 72nd St., will soon award the contract for the construction of a 1 story, 70 x 240 ft. factory on Sideway Ave. and East 65th St. Estimated cost, $50,000. P. Matzinger, Caxton Bldg., Archt.

O., Cleveland—The Premier Refining Co., 1187 West 11th St., plans to alter its 2 story factory on Harvard Ave. Estimated cost, $35,000. Service Constr. Co., 6110 Euclid Ave., Archt.

O., Painesville—The Middle States Rubber Co., c/o E. Ewing, 708 Williamson Bldg. Cleveland, is having plans prepared for the construction of a 2 story, 60 x 200 ft. factory and warehouse. Estimated cost, $200,000. Osborn Eng. Co., 2848 Prospect Ave., Cleveland, Archt. and Engr.

Wis., Delavan—The State Bd. of control, Madison, will receive bids until Dec. 28, for the construction of a 1 story, 32 x 65 ft. laundry, at the State School for the Blind, here. Estimated cost, $20,000. A. Peabody, Madison, State Archt.

Wis., Manitowoc—The Manitowoc Products Co., 10th and Washington Sts., is having preliminary plans prepared for the construction of a 2 story, 55 x 142 ft. bottle factory on Washington St. W. J. Raeuber, 826 South 8th St., Archt.

Wis., Milwaukee—The Atlas Bread Co., 927 Central Ave., is having plans prepared for the construction of a 2 story, 60 x 160 ft. addition to its wholesale bakery. Estimated cost, $75,000. A. Koch, Wells Bldg., Archt.

Wis., Plymouth—The Plymouth Phonograph Co., c/o W. A. Thomas, Pres., plans to build a 2 or 3 story, 60 x 185 ft. addition to its phonograph factory on Main St. Estimated cost, $75,000. Probably private plans.

Wis., Watertown—The Badger Concrete Mixer Co., 221 Grand Ave., Milwaukee, plans to build a 1 story, 80 x 300 ft. factory, here.

WEST OF THE MISSISSIPPI

Col., Lafayette—The Great Valley Sugar Co., 800 Central Savings Bank Bldg., Denver, has awarded the contract for the construction of a sugar factory. Estimated cost, $1,000,000.

Col., Pleasant Valley—(Noel P. O.) The Great Valley Sugar Co., Central Savings Bank Bldg., Denver, has awarded the contract for the construction of a sugar factory, here.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, plans to build a 2 or 3 story, mines experiment station, at the State University, here. Estimated cost, $250,000. D. F. Mullen, Secy. C. H. Johnston, 715 Capitol Bank Bldg., St. Paul, Archt.

Tex., Corsicana—The Frick Ice Cream Co. will receive bids until Jan. 1, for the construction of a 1 story, 35 x 40 ft. ice cream plant. Estimated cost, $20,000. B. H. Frick, Secy.-Treas.

Tex., Dallas—The Bd. Educ., Municipal Bldg., has awarded the contract for the construction of a 3 story high school, to include a manual training department, on Haskell and McKinny Sts. Estimated cost, $765,000.

WESTERN STATES

Cal., Los Angeles—The Coast Envelope Co., Higgins Bldg., plans to build a 2 story factory on a 140 x 160 ft. site on Santa Fe Ave. and Jesse St., to replace the one which was recently destroyed by fire.

CANADA

Ont., Kingsville—The Conklin Planing Mills plans to rebuild its plant which was destroyed by fire. Loss, $50,000.

Ont., Pembroke—McGuire, Patterson & Palmer, Ltd., 343 Dorchester St., Montreal, have awarded the contract for the construction of a match factory, here. Estimated cost, $5,000,000.

Ont., St. Catherines—The Kenleth Paper Co., Welland Canal, has awarded the contract for the construction of a 2 story addition to its paper factory. Estimated cost, $25,000.

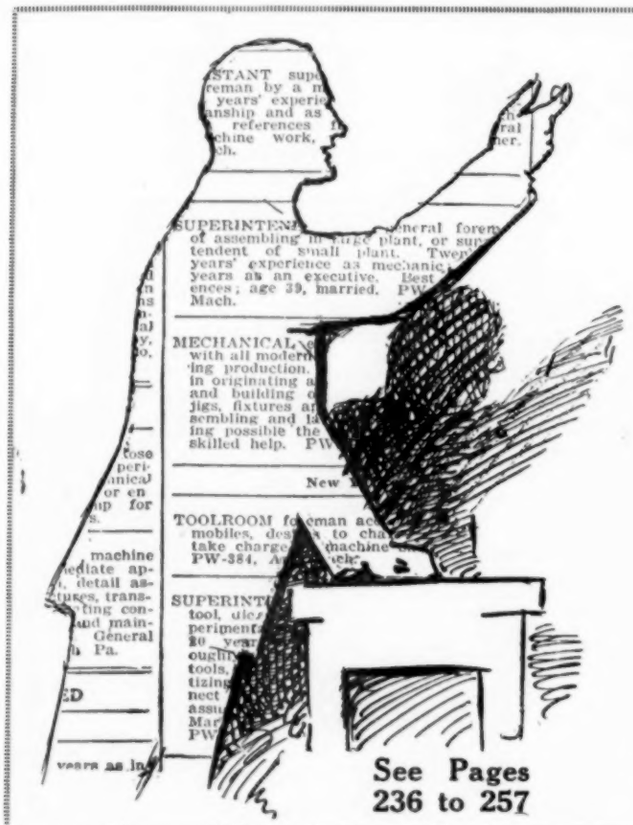
Ont., Wallaceburg—The Wallaceburg Glass Co., Ltd. plans to expend $50,000 on plant.

Ont., Welland—The Cross Fertilizer Co. Ltd., plans to build a 2 story fertilizer factory. Estimated cost, $250,000.

Que., Montreal East—The Dominion Carriage Co., Marien Ave., plans to build a 4 story addition to its plant. Estimated cost, $50,000. F. Arthur, Mgr.

Que., Montreal—I. Malo, 167 Dufresne St., will soon award the contract for the construction of a refrigeration plant. Estimated cost, $25,000.

Que., Three Rivers—The Three Rivers Pulp & Paper Co. has awarded the contract for the construction of a pulp and paper plant. Estimated cost, $500,000.



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